FEB 17 1953
FORESTRY LIBRARY

JOURNAL OF MAMMALOGY

VOL. 34 FEBRUARY 1953 NO. 1

AMERICAN SOCIETY OF MAMMALOGISTS

The American Society of Mammalogists

Founded April 3, 1919
Incorporated April 29, 1920

Officers

WILLIAM J. HAMILTON, JR., *President*
WILLIAM H. BURT, WILLIAM B. DAVIS, *Vice-presidents*
RANDOLPH L. PETERSON, *Recording Secretary*
KEITH R. KELSON, *Corresponding Secretary*
VIOLA S. SCHANTZ, *Treasurer*
W. ROBERT EADIE, *Editor*

Additional Directors

1951-1953	1952-1954
VICTOR H. CAHALANE	DONALD F. HOFFMEISTER
EMMET T. HOOPER	ROBERT T. ORR
J. KENNETH DOUTT	STEPHEN D. DURRANT
ANTOON DE VOS	ROBERT H. COLEMAN
JOSEPH C. MOORE	G. H. H. TATE

Past Presidents

HAROLD E. ANTHONY — A. BRAZIER HOWELL
H. H. T. JACKSON — E. RAYMOND HALL
WALTER P. TAYLOR — REMINGTON KELLOGG
TRACY I. STORER

Trustees

HAROLD E. ANTHONY (1953) LEE S. CRANDALL (1954) WILLIAM K. GREGORY (1955)

Standing Committees 1953-1953

Bibliography: David H. Johnson, *Chairman*. Claude W. Hibbard, Richard H. Manville Henry W. Setzer.
Conservation of Land Mammals: Ralph S. Palmer, *Chairman*. Frederick S. Barkalow, Jr., Victor H. Cahalane, George A. Bartholomew, Jr., Clarence Cottam, T. H. Manning, Antoon de Vos.
Economic Mammalogy: E. Raymond Hall, *Chairman*. E. L. Cheatum, C. H. D. Clarke, E. R. Kalmbach, R. A. McCabe.
Editorial: W. Robert Eadie, *Chairman*. Don W. Hayne, Claude W. Hibbard, Donald F. Hoffmeister.
Index of Journal of Mammalogy: Viola S. Schantz, *Chairman*. H. H. T. Jackson, David H. Johnson, Remington Kellogg.
Marine Mammals: Robert T. Orr, *Chairman*. H. Dean Fisher, Raymond M. Gilmore, Carl L. Hubbs.
Membership: A. R. Shadle, *Chairman*. Seth B. Benson, R. H. Coleman, W. B. Davis, John T. Emlen, Ross Hardy, Joseph C. Moore, Randolph L. Peterson, Richard Van Gelder.
Nomenclature: Colin C. Sanborn, *Chairman*. E. Raymond Hall, Donald F. Hoffmeister, Emmet T. Hooper, Remington Kellogg, George H. H. Tate, Robert W. Wilson.

The American Society of Mammalogists is a member of the International Union for the Protection of Nature, an affiliate of the American Institute of Biological Sciences, the A. A. A. S., and the National Research Council, and an exchange member of the Nature Conservancy.

The Journal of Mammalogy

Persons actively interested in mammalogy may become members of the Society upon nomination, payment of membership dues, and election. Applications for membership may be obtained from the corresponding secretary. The Journal of Mammalogy is sent free to all members of the American Society of Mammalogists not in arrears for dues ($4.00).

Subscription rates are $6.00 per year; single numbers of the Journal are $1.50 each.

Nominations and dues for membership, dues for subscriptions, changes of addresses, orders for back numbers and the two bound indexes, requests for missing numbers, and applications for advertising rates should be addressed to the Corresponding Secretary, Keith R. Kelson, Museum of Natural History, University of Kansas, Lawrence, Kansas.

Publications for inclusion in the bibliography of mammalogical literature, section on "Recent Literature," should be sent to David H. Johnson, Division of Mammals, U. S. National Museum, Washington, D. C.

Manuscripts for publication, books for review, and papers for special comment should be sent to the Chairman of the Editorial Committee, W. Robert Eadie, Fernow Hall, Cornell University, Ithaca, New York.

Journal of Mammalogy is published quarterly by the American Society of Mammalogists, Mt. Royal and Guilford Aves., Baltimore 2, Md. Entered as second class matter, November 22, 1919, at the Postoffice, Baltimore, Md., under the act of March 3, 1879.

Made in United States of America

JOURNAL OF MAMMALOGY

Published Quarterly by the American Society of Mammalogists

VOL. 34 FEBRUARY—, 1953 No. 1

SEASONAL AND SEXUAL DIFFERENCES IN THE DORSAL SKIN GLAND OF THE KANGAROO RAT (*DIPODOMYS*)

BY W. B. QUAY

Along the anterior part of the mid-dorsal line, in the most exposed area of the arched back, there is a specialized glandular area in the skin of the kangaroo rat (*Dipodomys*). Museum skins of all of the currently recognized species of *Dipodomys* (Setzer, 1949: 496), except *elephantinus*, *margaritae*, and *mitchelli*, were examined for the presence of this gland. All of the species examined possessed the gland in at least a few individuals. Investigation of other heteromyid genera failed to disclose its presence, and corroborates statements to that effect by Grinnell (1922: 11), Howell (1932: 399), and Hall (1941: 241; 1946: 377). Thus, the presence of a specialized dorsal skin gland is a generic character of *Dipodomys*. Careful scrutiny of many specimens has shown that the activity of the gland is not uniform from species to species, but presents striking seasonal and sexual modifications, which vary among the species (contrary to Grinnell, 1922: 11). In this report I shall describe the variations in glandular activity as correlated with season and sex for five species, *merriami*, *agilis*, *heermanni*, *deserti*, and *ordi*, and analyze the functional significance of these variations with reference to available information on the life histories and habits of the species.

The gross appearance of the gland has been described in various species by Grinnell (1922: 11), Vorhies and Taylor (1922: 6), Seton (1929: 431–3), Bailey (1931: 248; 1936: 236), Howell (1932: 399), and Tappe (1941: 131), but structural differences between species have not been commented upon. A study of the microscopic anatomy and histochemistry of the gland has been made and will be published elsewhere. This latter study has shown that the dorsal gland is an area of highly specialized sebaceous alveoli and possesses several unique features in regard to structure and composition, and also that species differences exist in the structure of the gland.

For facilities and helpful advice I am most grateful to Emmet T. Hooper and W. H. Burt, Museum of Zoology, University of Michigan. For the privilege of examining specimens in their care I wish to thank Colin C. Sanborn, Chicago Natural History Museum; B. P. Bole, Jr., Cleveland Museum of Natural History; and Viola S. Schantz, Biological Survey Section, Fish and Wildlife Service.

METHODS

The skins preserved in the collections of the four above-named institutions were examined for dorsal glands and the following data were recorded for each specimen: subspecies, locality, sex, age (adult or subadult to young), total length (mm.), date of capture (month and day), greatest length and greatest width of gland area (to 0.1 mm.), presence or absence of pillars of secretion, activity of the gland area (gland area lacking, area present but inactive, slight secretion, moderate to great amount of secretion). The data were recorded for each species separately and, within the species sample, the data were divided according to sex, age, and month of capture. For each adult specimen the surface area of the dorsal gland was calculated from $\frac{1}{4}\ \pi LW$, since the area is in the shape of an ellipse, or sometimes of a circle. Unlike the cutaneous glandular areas of many mammals, the dorsal gland of most species of *Dipodomys* is easy to measure, since the area has few if any hairs and the secretion forms a resistant mound, which is not likely to be greatly modified in size or shape during the drying of the skin.

For the monthly samples of adults of each sex the per cent having secreting glands and the mean area of the gland were calculated. In some instances where few specimens were available from certain months, the samples of two or three adjacent months were grouped together. In such cases the sample sizes and values for the component months were about the same. Grouping of the specimens according to month of capture is an arbitrary and convenient way of obtaining seasonal samples. In most of these the specimens are representative of different times within the month, and should give a fairly reliable picture of the average condition. Samples from months during which rapid changes in the gland are occurring may give a distorted impression of the precise status of the gland if the samples are more representative of one of the extreme dates within the month. However, as far as gland status relative to preceding and following months is concerned, a fair appraisal might still be made, provided that one or more sharp reversals in direction of glandular activity do not occur within a sample. Subdivision of the monthly samples into smaller ones is not feasible since already the samples suffer from small size. Determination of the exact time within a month which a sample best represents is not considered advantageous, since within the samples there is so much variation and so few individuals that shifting of the monthly means and percentages would not significantly affect the results. Nevertheless, the monthly samples should suffice to show the general seasonal trends in glandular activity where variations in the amplitude of the activity are of a detectable magnitude.

Owing to the lack of series of specimens representing all seasons at a single locality, specimens of a single species or racial group from different localities had to be grouped together in order to acquire samples of significant size. The racial and geographic variation within the species samples was reduced to the minimum by the selection of certain well-represented areas and races. And the validity of the grouping of specimens of different races and localities was tested by comparing different racial or geographic segments of the sample with each

other. In *ordi* it was found that the monthly mean area of the gland was not the same in all segments of the species sample, but that the per cent of the adults of each sex with secreting glands did follow the same monthly pattern in all segments. In the species *merriami*, *agilis*, *heermanni*, and *deserti* the samples from different areas and races appeared to be equivalent, both in respect to monthly mean gland size and in respect to per cent of adults secreting.

The use of series of museum specimens to portray events occurring in natural populations presumes that these series are unbiased samples. This is probably a safe assumption, but it is not possible to prove its being so.

The results of the glandular activity survey are graphed in Figures 1 through 5. At the bottom of these graphs are boxes containing the "sample size," or number of individuals in each monthly sample used in the graph or graphs. The upper row of figures concerns males, the lower females. Along the abscissae of the graphs the months are symbolized by their first letters, starting and ending with January. Dashes between months indicate that specimens from these months were grouped together. In the graphs of per cent of adults secreting, the percentages are shown by dots (solid for males, open for females). The upper and lower borders of the rectangles (solid lines for males, broken for females) surrounding the dots indicate the 95 per cent confidence limits for binomial distribution (Clopper and Pearson, 1934). Where these rectangles do not overlap the same values along the ordinate, they are considered to be significantly different. In the graphs of mean gland size the means are shown by dots (solid for males, open for females), and the rectangles (solid lines for males, broken for females) indicate a distance of two times the standard error of the mean on either side of the dots. Where these rectangles do not overlap the same values along the ordinate they are considered to be significantly different, at least in the case of the larger samples. With the t value set at 2 for the means of all samples, the probability that the monthly population mean lies outside the indicated limits is about 10 per cent for the smallest sample and 5 per cent for the largest (Snedecor, 1946: 65).

OBSERVATIONS

D. merriami.—Figure 1 shows unequivocally that the dorsal gland in this species, both in its areal extent and secretory activity, is a definitive and cyclic specialization of adult males, following an annual cycle of great activity from February to June and slight activity from August to December, July and January being months of transition.

The only previous mention that I have found concerning the sexual difference in the gland in this species is that by Hatfield (1942: 153), who found the dorsal skin gland more extensive in area and more protuberant in males than in females in a series of April and May specimens.

The greatest number of molting specimens in the adult samples occurred in the months of July, August, September, and October for both sexes, July being the month of greatest molt activity. Two December females were molting and two April and two June males were also. One of the April males had a large and heavily-secreting gland, the other had a small and non-secreting gland and large testes. The molting June males had small but heavily secreting glands. Grinnell (1922: 77) believed *Dipodomys* to have but one molt a year, in the fall, and described the molt in a specimen of *merriami* taken on September 25. Burt (1934: 414) described four July and August and two May specimens from Nevada which were

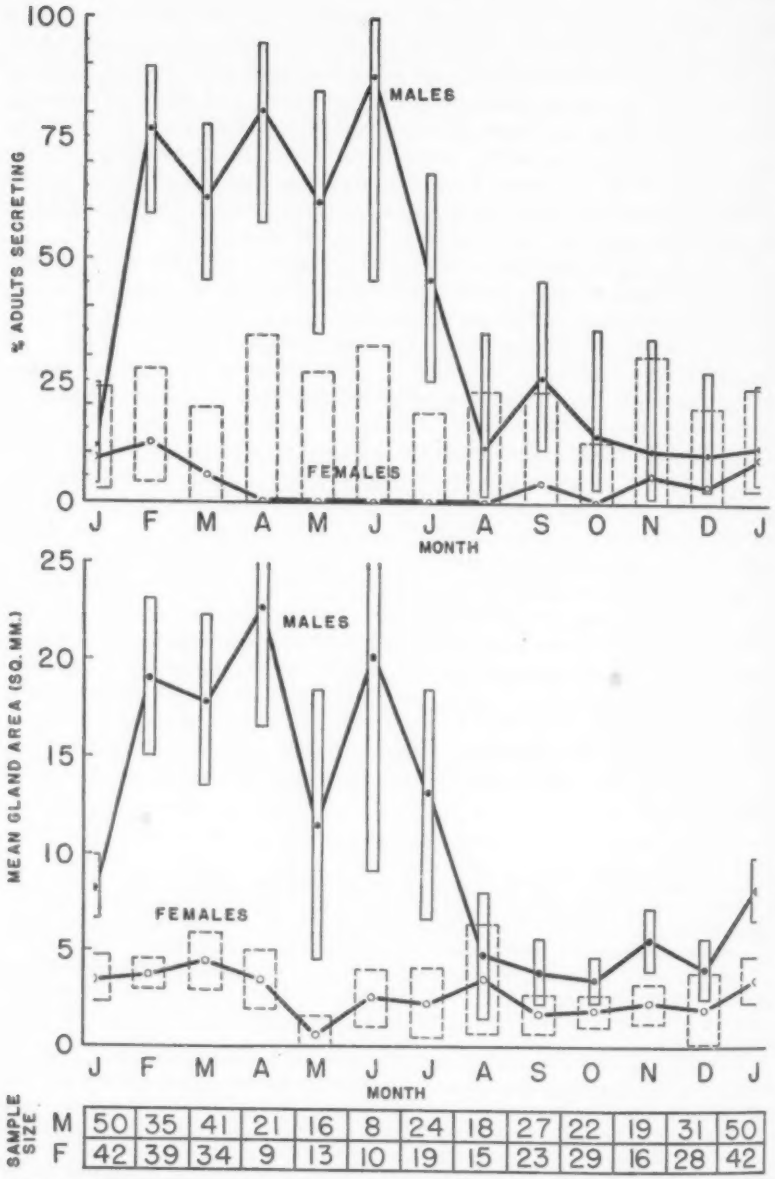


FIG. 1.—Monthly dorsal gland activity in *Dipodomys merriami* as expressed by per cent of adults secreting and by mean gland area.

molting. He considered the fall molt to be a complete one, but the occurrence of a partial spring molt was thought to occur sometimes, possibly due to abnormal conditions. For this species in Nevada, Hall (1946: 427) stated that molting individuals were taken from July 18 to August 3. Thus, it appears that the annual molt, in most of the adult population at least, occurs concurrently with the decline in the activity of the dorsal gland of the males; but active glands and molt may be found together on the same specimens.

Information on the breeding season in this species is widely scattered, but when it is brought together it conforms to a distinct pattern. Stephens (1906: 159), remarking on *D. m. simiolus* in California, stated that young are born mostly in April and May. In the San Jacinto area, Grinnell and Swarth (1913: 355–6) noted that young had appeared in numbers during the latter part of May. In the lower Colorado valley the breeding season was at its height in April, though females with embryos were taken from February 19 to May 8 (Grinnell, 1914: 242). Bailey (1931: 265) noted a pregnant female collected in New Mexico in August. Burt (1933: 119) remarked that three females taken at Continental, Arizona, April 26, had the mammary glands active. In southern Nevada (Burt, 1934: 413) pregnant females were found as early as May 27 and as late as August 1. In Death Valley from April 5 to 21, seven out of twenty females collected were pregnant (Grinnell, 1937: 145). Young of the year already two-thirds grown were taken as early as April 8, which was interpreted as showing the beginning of the breeding season to have occurred in middle or early March. By April 22, immatures were common. Alcorn (1941: 88–9) examined 141 females from Nevada and found that more than a third of all females taken in each of the months March, April, and May were pregnant. From this he concluded that some females have more than one litter a year. Females with enlarged uterine horns were found in February and March, pregnancies in March, April, and May, and active mammae without pregnancy likewise in March, April, and May. None of the August and September specimens had embryos or young. Huey (1942: 361) found eleven pregnant females in a series of forty specimens taken between February 22 and May 11. Capture of pregnant females ranged evenly throughout this collecting period. Blair (1943: 28–9), in southern New Mexico, found that the breeding season did not begin until early March, after trapping was initiated, and that breeding was still in progress when field work was discontinued in late May. Of eight males examined during March 4–16, only two had enlarged testes in breeding condition. In the March 17–29 period, 79 per cent of the males were in breeding condition, and during subsequent periods extending through to May 24, from 86 to 100 per cent of the males examined were sexually active. Examination by Blair of specimens in alcohol revealed that males with enlarged testes occurred in nine out of twelve specimens taken July 3 to 15, one specimen taken August 12–16, and two out of five taken on October 11; that females with vaginal plugs occurred in one out of twelve taken July 3–15, one of two taken August 12–16; that three females had recently lactated out of the series of twelve taken July 3–15; and that two others of this series contained embryos. Blair also had evidence that some females gave birth to two litters during the breeding season. Hall (1946: 427), including the animals reported on by Alcorn (above), recorded the results from 324 mature females examined for embryos. From his data it appeared that most of the young are born in the spring, from March through July, although in July relatively fewer females are pregnant than in any one of the four preceding months. Johnson *et al.* (1948: 363), reporting on 100 specimens collected during the months of January, April, May, June, and December, noted that the breeding season appeared to begin in April, reach its peak in May, and extend through June. The reproductive condition of many of the winter-caught females used in the dorsal gland survey was recorded by the collector. Of these, none of the seven adult December females and likewise none of the thirty January females examined had any embryos. The above data from many authors and regions shows that the successful breeding season in *merriami* is typically the period from February to June inclusive. The end of the breeding season appears to be less well defined than its start. The breeding season in this species, therefore, coincides remarkably well with the period of dorsal gland activity in the adult males.

Attempts to associate the period of dorsal gland activity with other seasonal patterns have not been successful. The home ranges of mature males of this species do not vary significantly in size from month to month and the home ranges of both males and females broadly overlapped others of the same sex, during the spring at least (Blair, 1943: 26–7). There is no evidence that the dorsal gland functions as a scent warning to other males. But the coincidence of glandular activity with the breeding season may indicate that it is a scent organ functioning only in relation to breeding behavior.

D. agilis.—Figure 2 demonstrates that the dorsal gland in this species follows a pattern similar to that seen in *merriami*, but that both the sexual and the seasonal differences are not so sharply drawn. The cycle of glandular activity in the males is characterized by a gradual rise starting early in the fall (rather than in January as is the case in *merriami*), and a more restricted period of peak activity, occurring from April to June (rather than from February to June). The sharp decline in July is the same as in *merriami*.

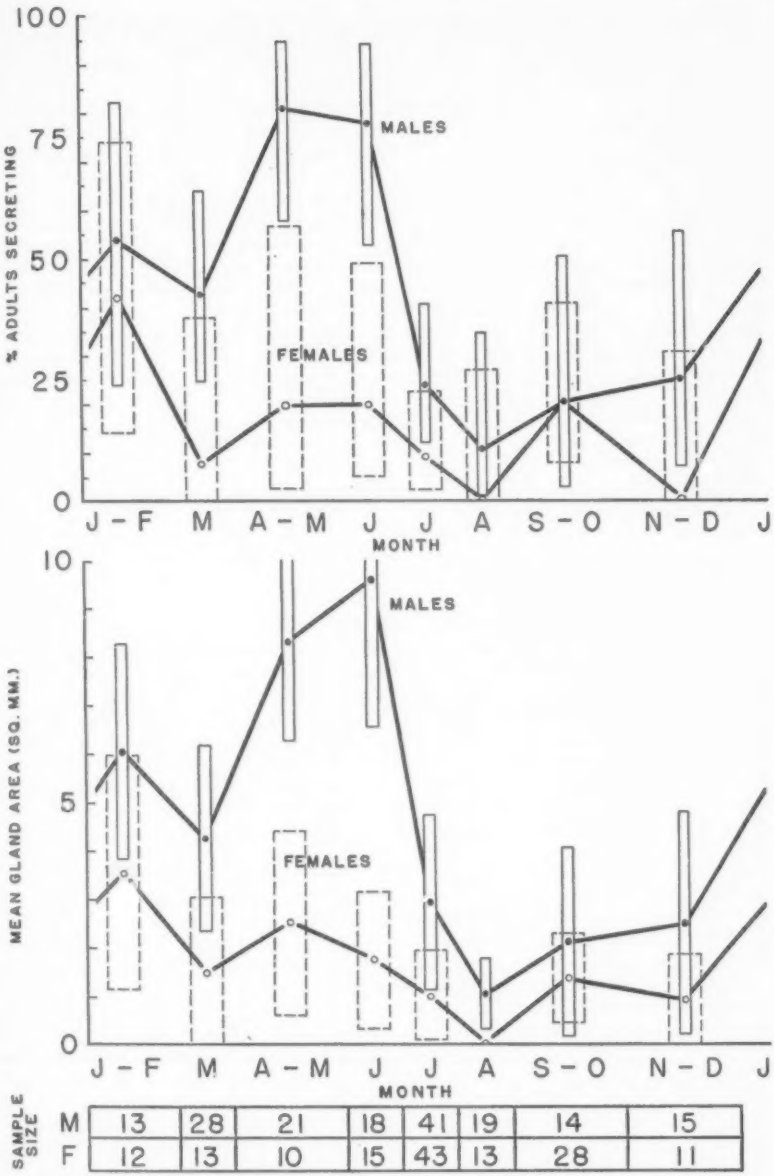
Grinnell (1922: 88) found molting specimens of *agilis* ranging in date from July 11 to September 20, and stated that there is but one annual molt in the adults. The series of specimens used for the dorsal gland study contained molting individuals from July 3 to October 3 with the greatest proportion of molting specimens occurring in the latter half of July and the month of August, both sexes behaving the same. Hence the annual molt coincides with the rapid decline in dorsal gland activity.

Knowledge of the breeding season and reproduction in *agilis* is slight. Stephens (1906: 153) stated that the greater number of young are born in the spring, but reproduction continues to some extent through the summer and autumn. Grinnell (1922: 89) found specimens in juvenal pelage bearing dates from May 24 to October 4, and thought that there was but one litter a year. In collections examined in the dorsal gland survey, juvenal pelage was found on specimens representing most of the months of the year, but the number of these individuals was greatest and their general size was smallest in the period from May to July. Three specimens preserved in alcohol in the University of Michigan Museum of Zoology, and collected in San Diego County during the period May 14 to 21, consist of one subadult male with minute testes and two pregnant adult females. What little information there is available seems to agree that there is a peak in breeding activity in the spring. This would correspond to the peak in the dorsal gland activity of the males.

D. heermanni.—The dorsal gland activity of this species (Fig. 3) appears to follow a markedly different pattern from that attending *merriami* and *agilis*. This results from: (1) the loss of significant sexual differences, (2) the near loss of significant seasonal differences, although a possibly significant peak in mean gland area still occurs in April males, and (3) the continuous secretion throughout the year in about 90 per cent of the adults. The species *merriami*, *agilis*, and *heermanni* present an interesting progression from great seasonal and sexual specialization to nearly no such specialization. The sharpest discontinuity in this series exists between *merriami* and *agilis* on the one hand and *heermanni* on the other, in regard to the shift from secretory activity primarily in spring males to secretory activity in most adults throughout the year.

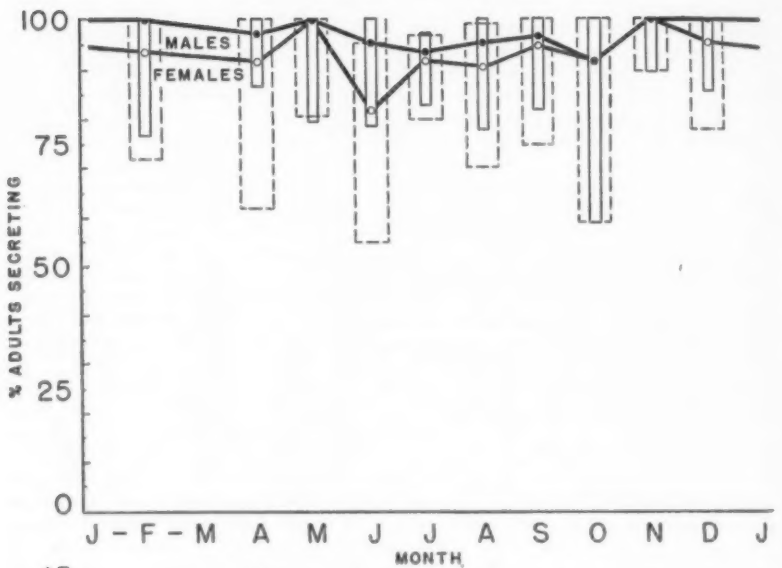
Specimens in various stages of the single annual molt were found by Grinnell (1922: 37) to date from July 31 to November 7, the latter date being exceptionally late. The annual molt in adults (in my samples) occurred primarily in July, August, and September, with the extreme dates being June 30 and November 26. Although the annual molt in *heermanni* occurs at a similar time and for a similar duration as that of *merriami* and *agilis*, it is not associated with a sharp decline in dorsal gland activity.

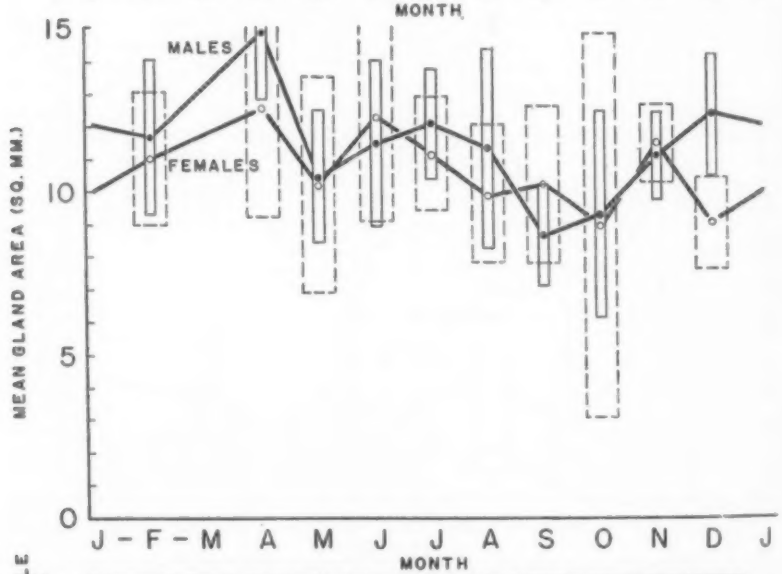
The breeding season of *heermanni* is well known, due primarily to recent studies by Tappe (1941) and Fitch (1948). Tappe (1941: 135) found the highest percentage of pregnancy to occur in April and noted the extreme pregnancy dates of January 5 and November 27. Fitch (1948: 22–4) found that breeding was almost, but not quite, discontinued during November, December, and January, and increased to a peak in April; it then gradually tapered off through the summer months. There was also evidence of multiple litters annually. These statements are in agreement with data presented by previous authors (Ste-



SAMPLE SIZE	J – F	M	A – M	J	J	A	S – O	N – D
M	13	28	21	18	41	19	14	15
F	12	13	10	15	43	13	28	11

FIG. 2.—Monthly dorsal gland activity in *Dipodomys agilis* as expressed by per cent of adults secreting and by mean gland area.





SAMPLE SIZE											
M	15	42	18	27	52	24	29	12	40	28
F	18	13	18	17	51	23	21	12	42	24

FIG. 3.—Monthly dorsal gland activity in *Dipodomys heermanni* as expressed by per cent of adults secreting and by mean gland area.

phens, 1906: 155; Grinnell *et al.*, 1930: 503, 507; Bailey, 1936: 240; and Dale, 1939: 715–6). As far as the secretion of the dorsal gland is concerned, there appears to be no relationship with the breeding season. In regard to the mean gland area there is a slight indication that peak size in the glands of males occurs in April, the height of the breeding season, but the gland in midwinter males is really not significantly smaller.

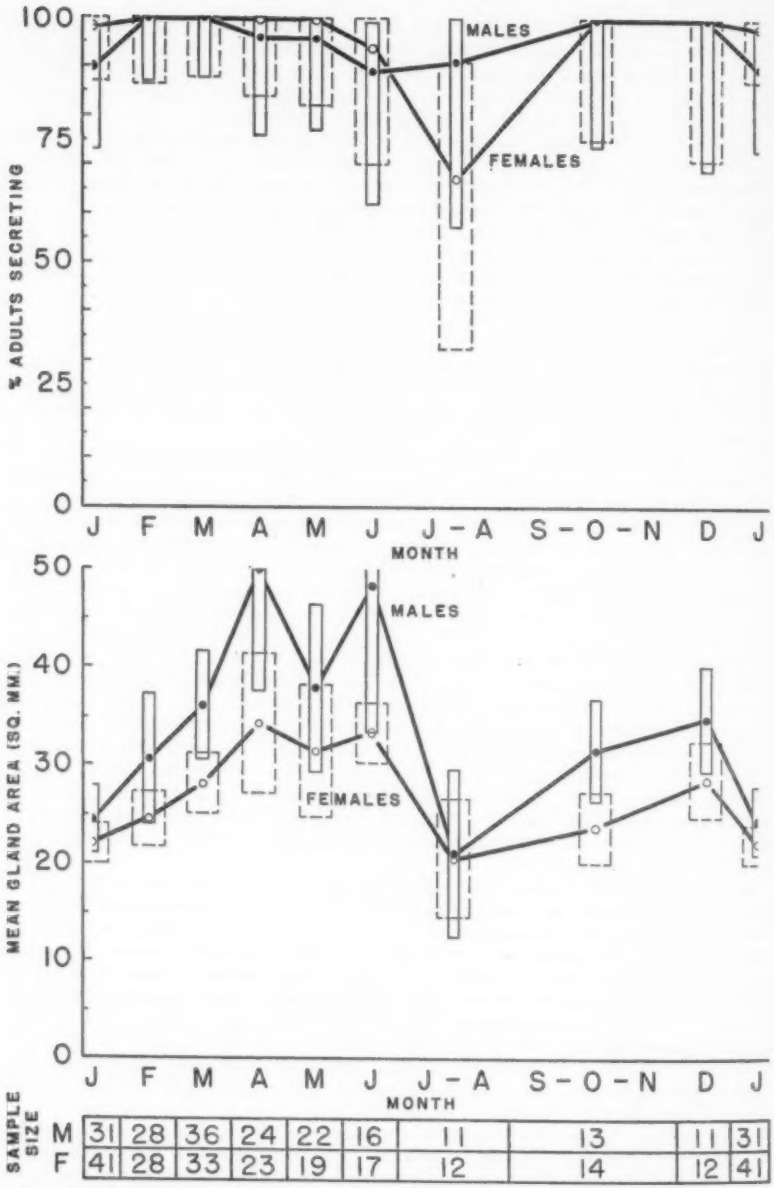
D. deserti.—In this species the glandular activity follows a configuration somewhat like that in *heermanni*, since secretion is approximately uniform in the sexes and continuous throughout the year (Fig. 4). However that may be, the mean area of the gland, although approximately the same in the sexes, shows significant seasonal differences with a major peak from April to June and a minor peak in November and December. This latter peak may be significant, but is not beyond doubt. These peaks are separated by a deep valley in July and August and a small, but possibly significant one in January and February. Therefore, there may be two cycles of glandular activity in this species, as expressed by gland size, in contrast to the single annual cycle found in the foregoing species.

Molting adults noted by Grinnell (1922: 107–8) and those noted in the course of the gland survey, indicate that there is a single annual molt, which occurs in the period from July to September. This again, as in *merriami* and *agilis*, coincides with the time of greatest reduction in gland size. Interestingly, in *deserti* there is evidence that the area of the gland in females as well as males decreases at this time.

Knowledge of the breeding season in *deserti* is rather deficient. Burt (1934: 415) stated that young about two-thirds grown were taken on June 7 and July 31, and that females with active mammae were taken on June 6 and February 6. Grinnell (1937: 151) reported pregnant females for April 8 and 17, and the first young of the year on April 13. Hall (1946: 431) recorded pregnancies for six of thirty-five females distributed as follows: January, 6 (1 pregnant); February, 1; March, 5; May, 12 (3 pregnant); June, 8 (2 pregnant); July, 2; September, 1. He wrote further that Alcorn (MS) noted that three females taken on March 24 were suckling young. Johnson *et al.* (1948: 363–4), who recorded twenty-two specimens taken on the dates May 26 and June 18–23, found none of the eleven females to be pregnant, but noted young or half-grown rats on June 19 and 20. In my series of specimens, a female taken on March 28 was noted by the collector as being pregnant, and juvenile specimens were found from all months except those in the period July–November. These data seem to indicate that breeding may take place during most of the year, except possibly during midsummer, and that a probable peak occurs in the spring. This would probably coincide with the spring peak in dorsal gland size, but whether there is a separate fall peak in the breeding season or merely a gradual increase in breeding activity leading up to the spring condition is an open question. Seton (1929: 433) stated that the dorsal gland in this species is enlarged and more active in the breeding season, which he probably considered to be spring.

D. ordi.—Since this species is so widespread geographically and has so many races, specimens representing the seven southernmost races and the northernmost race were excluded. Even so, the remaining group of specimens proved to be highly variable. This was especially true in regard to the size of the gland area. The monthly means of the gland area for adults of each sex of members of the Great Plains complex of races (Setzer, 1949: 504–5) were plotted separately as were also those for members of the combined southwestern, western, and intermontane complexes. These graphs showed that month by month the mean gland area for either sex in the Great Plains complex was greater than that for either sex in the combined complexes in 90 per cent of the cases. Lack of a sufficient number of specimens prohibited dividing the samples still further, in the attempt to correlate size and size variation with race or region.

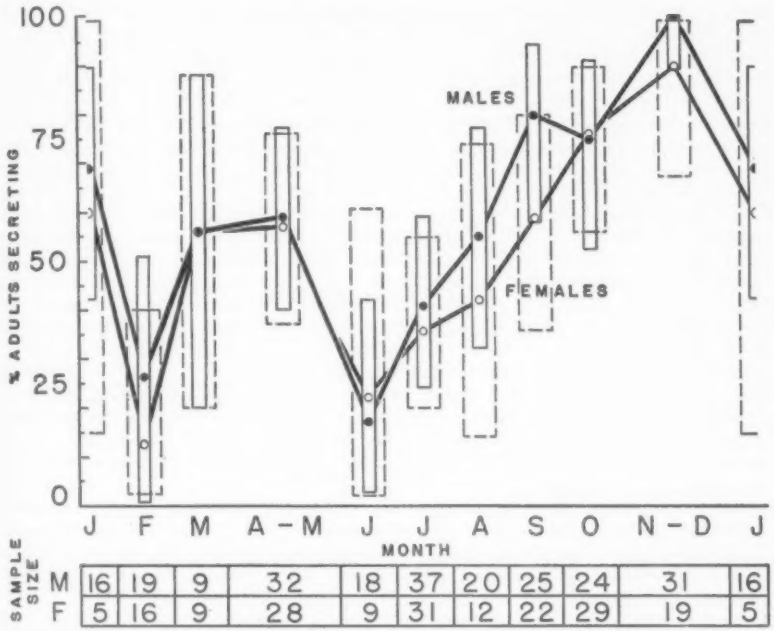
In the monthly pattern of secretory activity there was found to be less variation than in the monthly mean gland size, since several races could have glands of different sizes, but following the same cycles of secretion and inactivity. Whether different geographic or racial segments of the species population do follow the same cyclic pattern was analyzed by dividing the specimens into contrasting groups, each sex separately. First, specimens of the



SAMPLE SIZE	J	F	M	A	M	J	J – A	S – O – N	D	J
M	31	28	36	24	22	16	11	13	11	31
F	41	28	33	23	19	17	12	14	12	41

FIG. 4.—Monthly dorsal gland activity in *Dipodomys deserti* as expressed by per cent of adults secreting and by mean gland area.

Great Plains complex were compared with those of the combined western, southwestern, and intermontane complexes. And secondly, specimens from north of 37° N. lat. were compared with those from south of this parallel. In all of these samples there were two peaks in secretory activity, one in the spring and one in the early winter; the latter peak was always the greater. It was, therefore, thought permissible to lump the groups in the graph (Fig. 5) in an effort to show the seasonal activity of the gland in *D. ordi* (excluding the seven southern races *obscurus*, *idoneus*, *palmeri*, *fuscus*, *sennetti*, *attenuatus*, and *compactus*, and the northern race *terrosus*). The two apparent peaks in activity were in all trial samples separated by the midsummer decline and rise, and in samples which contained winter specimens by the more abrupt and less significant late winter decline and rise. All samples



SAMPLE SIZE	J	F	M	A – M	J	J	A	S	O	N – D	J
M	16	19	9	32	18	37	20	25	24	31	16
F	5	16	9	28	9	31	12	22	29	19	5

FIG. 5.—Monthly dorsal gland activity in *Dipodomys ordi* as expressed by per cent of adults secreting.

except those from north of 37° N. lat. contained winter specimens, and in this exception the months December to March were unrepresented. This hiatus does not indicate that northern kangaroo rats are inactive during the winter (see Davis, 1939: 269–70; Hall, 1946: 406); rather, it suggests that few collections are made in cold weather.

Figure 5 demonstrates that in *ordi* there is no sexual difference in the secretory activity, but that there are great seasonal differences, which follow a pattern different from those described for the preceding species.

The season and duration of molt in *ordi* appears to be similar to that reported for the above species. Of 31 Nevadan specimens clearly showing molt, 23 were taken in July (Hall, 1946: 411); the extreme dates were June 11 and August 27. In the series examined for dorsal glands, molting adults were also numerous in September and October; the latest was December 10. Unlike the preceding species, whose glandular activity either decreases greatly

or remains the same during the annual molt, in *ordi* the gland increases in secretory activity during the annual molt. The molting adult specimens in the *ordi* series examined were not distinguished in their dorsal gland activity. Some lacked discernible glands; others had large and highly secreting glands; and intermediate types existed.

Available information on the breeding season in *ordi* is abundant, but fragmentary and difficult to interpret. Bailey (1905: 144) found four out of ten adult females from New Mexico, collected from November 29 to December 6, to be lactating, and numbers of full-grown young were collected at the same time. Two pregnant Californian *ordi columbianus* females were collected on July 7 (Grinnell *et al.*, 1930: 508). Bailey (1931: 268, 273), for New Mexico, noted a pregnant female October 12 and one June 20, and noted numbers of half-grown young during the latter half of June. Burt (1933: 119) noted a pregnant female taken in southern Arizona on May 4 and two lactating females taken on April 28 and May 13. Borell and Ellis (1934: 29) record two pregnant females from northern Nevada taken on August 7 and 8 and four half-grown young captured between June 24 and 27. Davis (1939: 270), for *columbianus* in Idaho, records gravid females for May and June and third-grown young for May 30. Warren (1942: 182, 184) records a pregnant female for April 20, nursing females for about the first of July, half-grown young for May and July, and a three-fourths grown young for the last of November (Colorado). Blair (1943: 24–6) found, in southern New Mexico, a spring breeding season of at least three months and at least some reproduction in the fall. He made extensive studies, from March 4 to May 24, of both *ordi* and *merriami* in the same area and found that the breeding season of *merriami* began somewhat later than that of *ordi*. Booth (1943), in Washington, found the mating season to occur about the middle of January and to continue to the first part of February in captive *columbianus* specimens, and records further the capture of a number of pregnant females in February and March. Allan (1944) describes breeding behavior in *ordi richardsoni* captives in Texas on November 13. Duke (1944), lacking specimens from February, October, November, and December, and combining data for *ordi columbianus* and *microps bonnevillei* from Utah, postulated that these species have two main breeding seasons a year and two periods of anestrus, the breeding seasons occurring from early January to (possibly through) March and from early September through October, the anestrus periods occurring from late June to late August and from late October or early November until late December or early January. Hall (1946: 411), for 291 Nevadan female specimens, found pregnancies in the months February through July, but lacked specimens from October through January. The proportion of pregnancies was greatest for the months February through April. The above data should certainly indicate that what is needed is a study of the breeding activity at fixed localities for all months of the year. It is not unlikely that the breeding season is different in diverse regions or races. Assuredly the data show little if any correspondence between breeding season and dorsal gland activity.

General.—Opinions on the function of the dorsal gland have been advanced frequently (Grinnell, 1922: 11; Vorhies and Taylor, 1922: 6–7; Seton, 1929: 431–3; Bailey, 1931: 248, 1936: 236; Howell, 1932: 399; Hall, 1946: 405). These can be divided into two categories: (1) those relating the gland to dressing the hair or skin with an oily secretion, and (2) those classifying it as a scent organ. The first of these categories of explanations does not seem particularly helpful, since well-developed and active sebaceous glands are probably distributed over nearly all of the skin and are capable of carrying out this function, and since the dorsal gland is a compact and localized structure. In regard to a scent function there are numerous possibilities. It would be useless to comment upon all of these, but it is of interest to note that the gland is active only in adult breeding males of some species and is active in both sexes throughout the year in others, indicating possibly different functional relationships in different species, in the one instance concerned with breeding behavior in the other concerned perhaps with individual identification.

There is evidence in the series of specimens examined for dorsal glands that the age at which the glands appear externally varies considerably from species to species. But, since the ages of the specimens were impossible to determine, further analysis was not feasible.

It is apparent that the activity of the dorsal gland has taxonomic significance. In *ordi* at least this may extend to the subspecific level. It is dubious whether we can show as yet any of the phylogenetic trends of the glandular activity within the genus. Nevertheless, it is worthwhile to remark that *ordi*, the most generalized species of the genus (Setzer, 1949: 484), has the most variable and unaccountable dorsal gland activity and lacks sexual differences. The greatest glandular specialization sexually and seasonally occurs in *merriami*, a morphologically rather highly specialized species. But then in *deserti*, the most specialized species morphologically, the glandular activity is about the same in both sexes and shows much less seasonal modification, than is found in *merriami*.

CONCLUSIONS

It can be seen that the specialized sebaceous dorsal gland of *Dipodomys* follows different patterns of activity in different species, that sexual and seasonal differences are present in some species and not in others, and that certain phases of activity may be associated with the breeding season or with the annual molt in some species but not in others. The fact that some of these species have broadly overlapping ranges and habitats suggests that physiological rather than environmental events are responsible. The functional significance of the gland would seem to concern scent responses. The behavior patterns associated with the gland are probably different in at least some of the species, since the glandular activity is subject to great seasonal and sexual modifications.

LITERATURE CITED

Alcorn, J. R. 1941. Counts of embryos in Nevadan kangaroo rats (Genus *Dipodomys*). Jour. Mamm., 22: 88–89.

Allan, P. F. 1944. Mating behavior of *Dipodomys ordii richardsoni*. Jour. Mamm., 25: 403–404.

Bailey, V. 1905. Biological survey of Texas. U. S. Dept. Agr., N. Amer. Fauna No. 25: 1–222.

——— 1931. Mammals of New Mexico. U. S. Dept. Agr., N. Amer. Fauna No. 53: 1–412.

——— 1936. The mammals and life zones of Oregon, U. S. Dept. Agr., N. Amer. Fauna No. 55: 1–416.

Blair, W. F. 1943. Populations of the deer-mouse and associated small mammals in the mesquite association of southern New Mexico. Contrib. Lab. Vert. Biol. Univ. Mich., No. 21: 1–40.

Booth, E. S. 1943. Observations on the kangaroo rat in captivity. Murrelet, 24(1): 10–11.

Borell, A. E., and R. Ellis. 1934. Mammals of the Ruby Mountains region of northeastern Nevada. Jour. Mamm., 15: 12–44.

Burt, W. H. 1933. Additional notes on the mammals of southern Arizona. Jour. Mamm., 14: 114–122.

——— 1934. The mammals of southern Nevada. Trans. San Diego Soc. Nat. Hist., 7(36): 375–428.

Clopper, C. J., and E. S. Pearson. 1934. The use of confidence or fiducial limits illustrated in the case of the binomial. Biometrika, 26: 404–413.

Dale, F. H. 1939. Variability and environmental responses of the kangaroo rat, *Dipodomys heermanni sazatilis*. Amer. Midland Nat., 22: 703–731.

Davis, W. B. 1939. The Recent mammals of Idaho. Caldwell, Idaho, Caxton Printers. 400 p.

Duke, K. L. 1944. The breeding season in two species of *Dipodomys*. Jour. Mamm., 25: 155–160.

FITCH, H. S. 1948. Habits and economic relationships of the Tulare kangaroo rat. Jour. Mamm., 29: 5–35.

GRINNELL, J. 1914. An account of the mammals and birds of the lower Colorado valley, with especial reference to the distributional problems presented. Univ. Calif. Publ. Zool., 12(4) : 51–294.

——— 1922. A geographical study of the kangaroo rats of California. Univ. Calif. Publ. Zool., 24(1) : 1–124.

——— 1937. Mammals of Death Valley. Proc. Calif. Acad. Sciences, Fourth Ser., 23(9): 115–169.

GRINNELL, J., AND H. S. SWARTH. 1913. An account of the birds and mammals of the San Jacinto area of southern California, with remarks upon the behavior of geographic races on the margins of their habitats. Univ. Calif. Publ. Zool., 10(10): 197–406.

GRINNELL, J., J. DIXON, AND J. M. LINSDALE. 1930. Vertebrate natural history of a section of northern California through the Lassen Peak region. Univ. Calif. Publ. Zool., 35, 594 p.

HALL, E. R. 1941. Revision of the rodent Genus *Microdipodops*. Zool. Ser. Field Mus. Nat. Hist., 27: 233–277.

——— 1946. Mammals of Nevada. Berkeley and Los Angeles, Univ. Calif. Press. 710 p.

HATFIELD, D. M. 1942. Mammals from south-central Arizona. Bul. Chicago Acad. Sciences, 6: 143–157.

HOWELL, A. B. 1932. The saltatorial rodent *Dipodomys*: the functional and comparative anatomy of its muscular and osseous systems. Proc. Amer. Acad. Arts and Sciences, 67: 377–536.

HUEY, L. M. 1942. A vertebrate faunal survey of the Organ Pipe Cactus National Monument, Arizona. Trans. San Diego Soc. Nat. Hist., 9(32): 353–376.

JOHNSON, D. H., M. D. BRYANT, AND A. H. MILLER. 1948. Vertebrate animals of the Providence Mountains area of California. Univ. Calif. Publ. Zool., 48(5): 221–376.

SETON, E. T. 1929. Lives of game animals. Garden City, New York, Doubleday, Doran & Co., vol. 4 (part 1). 440 p.

SETZER, H. W. 1949. Subspeciation in the kangaroo rat, *Dipodomys ordii*. Univ. Kansas Publ. Mus. Nat. Hist., 1(23): 473–573.

SNEDECOR, G. W. 1946. Statistical methods applied to experiments in agriculture and biology. 4th ed., Ames. Iowa State Coll. Press. 485 p.

STEPHENS, F. 1906. California mammals. San Diego. West Coast Publ. Co., 351 p.

TAPPE, D. T. 1941. Natural history of the Tulare kangaroo rat. Jour. Mamm., 22: 117–148.

VORHIES, C. T., AND W. P. TAYLOR. 1922. Life history of the kangaroo rat *Dipodomys spectabilis spectabilis* Merriam. U. S. Dept. Agric. Bul. 1091: 1–40.

WARREN, E. R. 1942. The mammals of Colorado, their habits and distribution. Norman, Univ. Oklahoma Press. 330 p.

Museum of Zoology, University of Michigan, Ann Arbor, Michigan. Received January 22, 1952.

THE GROSS ANATOMY OF THE VISCERA OF THE PRAIRIE DOG

By Lyle C. Dearden

An anatomical study of the prairie dog, *Cynomys*, was suggested by Professor Stephen D. Durrant of the Division of Biology, University of Utah. Although the prairie dog is a common animal, it has seemingly not been studied extensively from the standpoint of anatomy. Stockard (1935) completed an extensive study of the female urogenital system. I have found no other studies on the visceral anatomy of this animal. The prairie dog has, however, been studied from the standpoint of its habitat (Seton, 1926). Its reproductive habits (Stockard, 1929), growth rate (Johnson, 1927), and habits in captivity (Cates, 1927) are well known. The taxonomy and range of the prairie dog were the subject of a monographic paper by Hollister (1916). In order to contribute to a more nearly complete knowledge of this animal, it has seemed advisable to undertake an anatomical study of its viscera.

In this study I have compared the visceral anatomy of the whitetail prairie dog (*Cynomys leucurus*) with published accounts of the anatomy of the pocket gopher, woodrat, albino rat, and kangaroo rat. I have not attempted to make a detailed study of the circulatory system, muscular anatomy, or nervous system.

Materials and methods.—I have dissected 16 prairie dogs in this study. In obtaining the specimens, an attempt was made to sample populations throughout the range of *Cynomys leucurus* in Utah. Two specimens were obtained at Price, Carbon County, Utah, by Robert Pendleton during the summer of 1947. The following spring (1948), I obtained seven specimens from five miles south of Vernal, Uintah County, Utah. These animals were taken during their breeding season. On July 9, 1948, Keith R. Kelson trapped two specimens five miles south of Castle Dale, Emery County, Utah. In late September, 1948, Dale C. Dearden and I obtained two prairie dogs five miles east of Vernal, Uintah County, Utah. In late October of the same year, Clifton Greenhalgh and Fred Reynolds obtained two more specimens from this same area. In early April, 1949, Dr. A. M. Woodbury obtained one male specimen at Duchesne, Duchesne County. Utah. This specimen was brought to the laboratory on ice, and was dissected in fresh condition as a final check.

To acquaint myself with the various anatomical aspects of the prairie dog, one of the first specimens was used in a preliminary dissection. The remaining animals were then used for dissection of the specific anatomical areas.

THE ORAL CAVITY

On either side of the oral cavity there is a fold of the integument which forms a hairy bristle pad caudad to the incisors. The purpose of this bristle pad is not known. There is no medial frenulum, but two lateral frenula attach the lower lip to the mandible. Prominent internal cheek pouches are present just under the skin, situated lateral to the masseter muscle.

The openings of the paired sublingual ducts are adjacent to the midventral line on the underside of the tongue, and about 12 mm. from the tip. The sublingual ducts empty into the paired salivary papillae, which are on the anteroventral surface of the tongue. Two circumvallate papillae are present on the dorsal surface of the tongue near the base. Greene (1935: 85) finds only one circumvallate papilla in the albino rat, as does Hill (1937: 140) in the pocket gopher.

GLANDS OF THE ORBIT

Exorbital lacrimal gland.—The exorbital lacrimal gland as described by Greene (1935: 86) is below and in front of the ear. In the prairie dog, I was unable to locate the gland. Howell (1926) does not mention the gland in the woodrat, nor does Hill (1937) in the pocket gopher. Midgley (1937: 41) describes this gland in the kangaroo rat in a location similar to that of the albino rat. It would seem that the gland is of functional importance in some animals, but not in others.

Intraorbital lacrimal gland.—The intraorbital lacrimal gland in the albino rat as described by Greene (1935: 86) is triangular in outline and occupies the posterior angle of the orbit. Midgley (1937: 41) described the gland in the same region in the kangaroo rat. In the prairie dog, I located triangular structures, occupying the prescribed area, which superficially appeared to be intraorbital lacrimal glands. Histological examination showed these structures to be adipose tissue. Neither Howell (1926) nor Hill (1937) mention the gland in their reports.

Harderian gland.—This gland is found between the posterior angle of the orbit and the eyeball. The gland is a narrow, bandlike structure, and lies in the shape of a horseshoe around the posterior portion of the eyeball.

GLANDS OF THE NECK

Parotid gland.—The parotid is a loosely-knit gland lying partially around the ventral portion of the pinna of the ear, and extending anteroventrad almost to the midventral line on the surface of the neck (Fig. 2). Its posterior border partially covers the clavicular region. The parotid duct (Stenson's duct) is formed by two main branches. Greene (1935: 86) describes the parotid duct of the albino rat as being formed by the convergence of three branches. Howell (1926: 92) describes this duct as arising from two branches in the woodrat.

Submaxillary glands.—These glands occupy the midventral region between the manubrium and hyoid (Fig. 2). They are large, more compact than the parotid, and usually meet in the midventral line for a short distance. The duct of each submaxillary gland proceeds forward superficially along the underside of the tongue, to a point 13 mm. from the tip, and opens into the oral cavity.

Sublingual glands.—The paired sublingual glands are long, oval, and narrow. They are located on either side, between the ventrolateral surface of the tongue and the dentary bones. The duct of each sublingual gland passes anteriorly into the salivary papillae. I could find no division into major and minor sublingual glands, as described by Greene (1935: 87) in the albino rat.

Multilocular adipose tissue.—The multilocular adipose tissue, hibernating, or brown fat gland, is an extensive, loosely knit type of gland. It is located in the interscapular space, and sends branches ventrocephalad to the region of the carotid body. The hibernating gland has a superficial resemblance to the parotid gland.

The name "hibernating gland" is misleading. These glands are found in some animals that do not hibernate, as well as in some that do. In the case of the albino rat, if the gland is removed surgically death ensues (Rasmussen, 1916, from Greene, 1935: 87). As yet, this gland has not been studied sufficiently to determine its exact function. Rasmussen (*op. cit.*, *fide* Greene) thought that "It possibly serves as an economizer of proteins by insuring utilization of reserve carbohydrates and fat during hibernation."

Carotid gland.—The carotid body is sometimes considered as endocrine in function (Greene, 1935: 89), but Smith (1924) was not in accord with this view (Greene, *loc. cit.*). Some authors consider this body to be a nerve plexus, and not actually glandular in structure (Greene, *loc. cit.*). In the prairie dog, there is indeed a large amount of nervous tissue dorsal to the bifurcation of the external and internal carotid arteries, medial to the vagus nerve, and posterior to the glossopharyngeal nerve. The chromaffin cells described in the connective tissue of the carotid gland (Robinson, 1921: 1343) are not present in the prairie dog, nor is there any glandular tissue as described by Maximow and Bloom (1947: 263).

It seems unlikely that the carotid gland is present in the prairie dog, at least as a discrete gland.

Thyroid gland.—The thyroid glands are located craniad and slightly dorsal to the thyroid cartilage on either side of the trachea. They are closely appressed to the posterodorsal surface of thyrohyoideus, and are connected across their posterior margins by an isthmus. Howell (1926: 99) found that the thryoid glands are small in *Neotoma*, and are not connected by an isthmus. According to Hill (1937: 143), the isthmus is also absent in the pocket gophers.

Parathyroid glands.—The parathyroid glands are considerably smaller than, and are embedded in connective tissue on the most anterior portions of, the thyroid glands.

THORACIC VISCERA

Trachea.—The trachea proceeds caudad from the larynx an average distance of 45 mm. before branching into the various lobes of the lungs (Fig. 2).

Thymus.—The bilobate thymus (Fig. 1) is folded around the most anterior part of the pericardium of the heart, and around the most posterior part of the trachea.

Heart.—The heart (Fig. 1) lies in the midline of the body with the apex directed toward the left.

The mediastinal septum extends from the heart to the midventral line, and encloses the thymus gland within its walls.

Lungs.—The right lung is composed of a superior lobe, a middle lobe, an inferior lobe, and a smaller fourth lobe surrounding the inferior vena cava, the postcaval lobe (Fig. 3). The left lung is simpler, and has only one lobe which folds over nearly half of the heart on its ventral surface. Hill (1937: 143) states that in none of the sciuroids or their relatives is the left lung single. This does not hold true in the prairie dog, in which the left lobe of the lung was single in all specimens I examined.

ABDOMINAL VISCERA (DIGESTIVE)

Esophagus.—The esophagus is a muscular tube beginning at about the level of the cricoid cartilage, and extending to the cardia of the stomach. The esophagus lies dorsal and slightly to the left of the trachea. It continues through the mediastinum, passes dorsal to the heart, through the central tendon of the diaphragm, and enters the cardiac portion of the stomach.

Liver.—The liver is divided into four lobes (Fig. 4). The median lobe is partially divided into a larger right loblet which contains the gall bladder, and a left smaller loblet. The left lateral lobe is the largest of the liver lobes. The right lateral lobe is divided into dorsal and ventral loblets. The caudate or Spigelian lobe is composed of two semicircular lobules, the anterior loblet partially curved around the esophagus, and the smaller posterior loblet (Fig. 4). The median lobe is supported by the falciform ligament, which extends to the midventral line. The lateral surface of the gall bladder is fused to the right loblet of the medial lobe. The terms 'dorsal' and 'ventral' seem more apropos than the terms 'anterior' and 'posterior' which were used by Hunt (1924: 78) in describing the loblets of the right lateral lobe. Hunt (*loc. cit*) also stated that from gross dissection he could find no hepatic tissue connection between the right lobe and any of the other lobes of the liver in the white rat. In the prairie dog, the right lobe is directly connected to the right loblet of the median lobe of the liver. The dorsal and ventral loblets of the right lobe are completely separated on their lateral surface, but not on their medial surface. Each loblet of the right lobe has a concavity which is occupied by the anterior portion of the right kidney. The right lobe is attached to the caudate at the mid-region of the latter. The anterior loblet of the caudate lobe of the liver is larger than the posterior loblet.

The cystic duct (Fig. 4), which drains the gall bladder (Figs. 1, 4), receives numerous hepatic ducts from the lobes of the liver, and empties into the duodenum as the common bile duct (Fig. 4). The bile duct runs caudad approximately 24 mm. before entering the duodenum at the ampulla of Vater in common with some of the pancreatic ducts. The ampulla of

Vater is approximately 24 mm. caudad of the pylorus. Hill (1937: 142) stated that there is no gall bladder in either pocket gophers or kangaroo rats. Howell (1926: 95) states that in

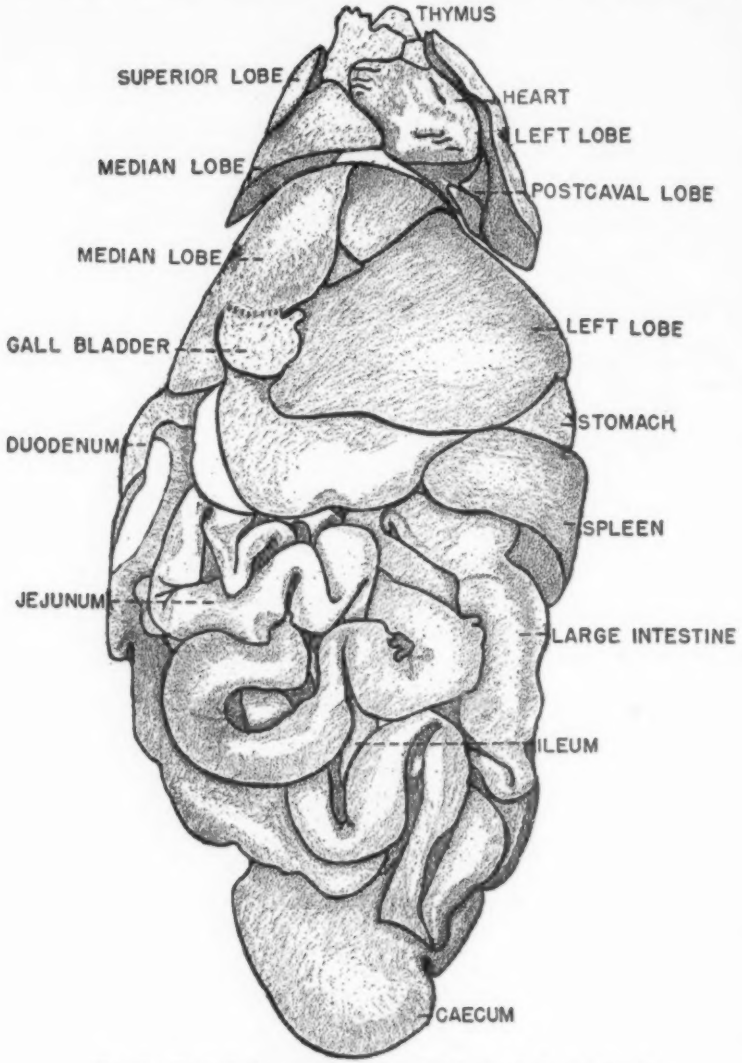


FIG. 1.—Ventral view of thoracic and abdominal viscera, *in situ*

Neotoma the median lobe is the largest of the lobes of the liver with the gall bladder being found between the right and left loblets of the median lobe.

The lesser omentum, ligaments of the liver, and gall bladder have the usual mammalian form and relationships.

Stomach.—The stomach is partially surrounded in its cranial region by the left lobe of the liver, to which it is closely appressed. In configuration, the stomach forms nearly a com-

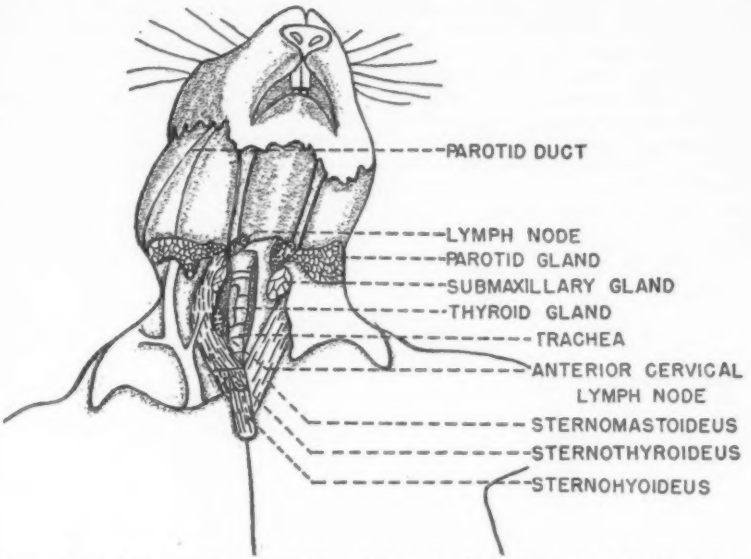


FIG. 2.—Ventral view of the superficial and deep glands of the neck. Left side deflected right side, *in situ*

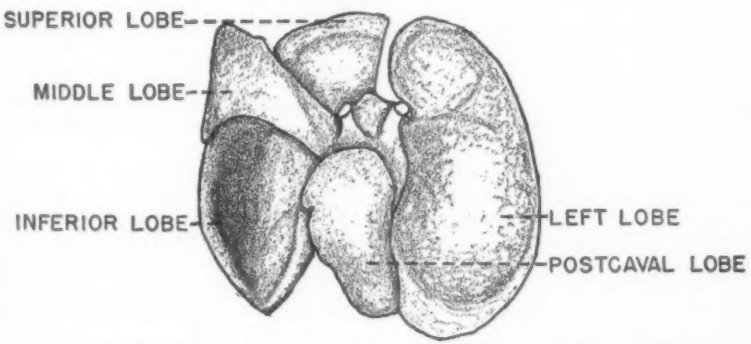


FIG. 3.—Ventral view of the lobes of the lungs. Lobes reflected from the midline

plete circle from the esophageal orifice in the cardiac region to the pyloric valve (Fig. 1). The left wall of the stomach, or the greater curvature, is thin and is lined with a pale whitish mucous membrane. The right side, or lesser curvature, in contrast, is nearly three times as thick, and is more muscular than the left side. In the pocket gopher, Hill (1937: 140) describes

large thickened fundic glands on the greater curvature opposite the openings of the esophagus and pylorus. In the prairie dog this condition exists only opposite the pyloric opening. In this area, the glands are at least five times thicker than in any other part of the stomach.

The mesogaster extends from the dorsal body wall to the greater curvature of the stomach. The fat-streaked greater omentum extends from the greater curvature of the stomach where it is continuous with the visceral peritoneum, over the visible portions of the stomach enclosing the spleen, and part of the pancreas. It does not extend far caudad, nor does it cover any but the most anterior portions of the intestine.

Spleen.—The spleen is a purple mass of lymphatic tissue which curves around the greater curvature of the stomach, and is attached thereto by the gastrosplenic ligament (Fig. 1).

Pancreas.—The pancreas is located on the left side of the stomach in close proximity to the spleen. It lies alongside the spleen toward the right side of the peritoneal cavity, whence it continues dorsad to a position near the duodenum. It then curves back through 270 degrees toward the pyloric valve. From the pyloric valve it extends along the duodenum, and ends at the point where the transverse limb of the duodenum begins. Hill (1937: 142) reported that only one duct drained the pancreas of the pocket gopher, and entered the duo-

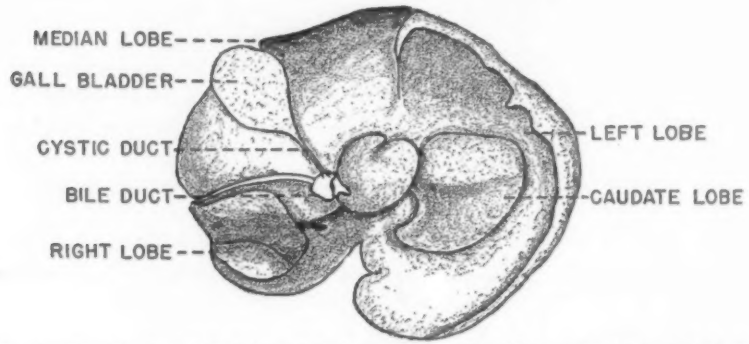


FIG. 4.—Caudal view of the lobes of the liver, with gall bladder, cystic duct, and bile duct *in situ*

denum with the common bile duct. In the prairie dogs I dissected, I found many ducts entering the duodenum at irregular intervals, and some entering in common with the bile duct.

Small intestine.—The small intestine (Fig. 1) is divided into three regions, the duodenum, the jejunum, and the ileum. The former has four subdivisions. The duodenum from the pylorus to the ampulla of Vater is called the superior part. The next section, of approximately 27 mm. length, extends caudad as the descending limb. The duodenum then turns left and continues transversly an average distance of 12 mm. as the transverse limb. It then turns cephalad as the ascending limb, and continues into the jejunum. Following the jejunum is the ileum; there is no definite boundary between the two. The ileum enters the dorsal part of the caecum.

The duodenorenal mesentery runs from the duodenum to the right kidney, and is the main supporting mesentery of the duodenum. Farther caudad, the intestine is supported by the mesentery proper, which is composed of many folds. The gastrocolic ligament is formed by a fusion of part of the mesogaster and the mesentery of the intestine. It is a short mesentery extending from the dorsal wall to the intestine. It is joined anteriorly by the gastrosplenic ligament.

Caecum.—The caecum is exceptionally large, often as large or larger than the stomach, and occupies a ventral position in the abdominal cavity (Figs. 1, 5). Hill (1937: 141) describes the ileum as entering the ampulla coli near the valve separating the ampulla coli and the cavity of the body of the caecum. In the prairie dog, the ileum does not enter near the aforementioned valve, but on the valve; the valve extends from it as projections around the wall of the caecum. It will be noted that the ileum does not enter directly into the caecum, but shares its entrance with the ampulla coli. This valve or partial septum, as described by Hill (1937: 141), consists of two plicae or loose flaps, which meet on the lesser curvature, but not on the greater curvature. I find this partial septum to extend from the iliocaecal valve around the ental side of the ampulla coli, with no decrease in size on either the greater or lesser curvature. The cavity of the body of the caecum is divided by partial septa, and these conform with those described by Hill (1937: 141) in that they are prominent

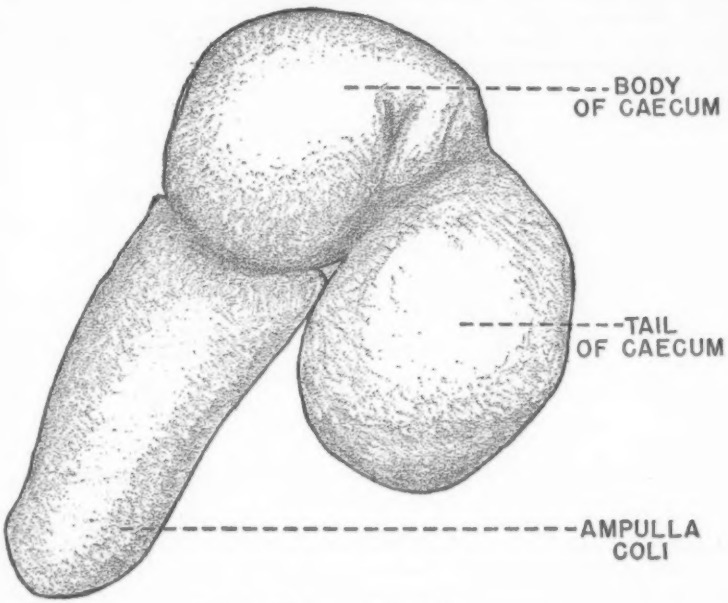


FIG. 5.—Ventral view of the caecum

on the lesser curvature, but absent on the greater curvature. These septa divide the caecum of the prairie dog into two cavities, the cavity of the tail, the larger of the two, and the cavity of the body. The cavity of the expanded large intestine is also present; this, however, is not actually a part of the caecum. The iliocaecal valve consists of puckered lips and a sphincter muscle surrounding the slit-like opening into the caecum ampulla coli region. The iliocolic valve is surrounded on two thirds of its circumference by puckered lips, but on the remaining third, the ridges seem to be minute or absent.

Large intestine.—The large intestine joins the caecum at the cervix of the latter, continues caudad an average distance of 77 mm., there makes an abrupt U-turn looping back on itself, and thus forms the ascending colon (Fig. 1). This loop is cross-connected with connective and adipose tissue. The ascending colon extends approximately 154 mm. before the sacculations typical of rodents are observed. These sacculations, the haustra coli, are

produced by the contraction of longitudinal muscle bands, the taeniae coli. Beyond the ascending colon, the large intestine is convoluted for a short distance; it extends across the peritoneal cavity about 34 mm. as the transverse colon. At the left side of the peritoneal cavity, the large intestine turns caudad as the descending colon, and at this point the mesocolon is fused to the mesogaster. The descending colon runs caudad and terminates dorsal to the urogenital sinus as the rectum. The rectum is supported by the mesorectum.

UROGENITAL SYSTEMS

Male.—The kidneys are located immediately caudad of the liver (Fig. 7). The suprarenal glands are also in this region; they lie parallel to the midline, and anteromedial to the kidneys (Fig. 7). While not part of the urogenital system, the suprarenal glands are mentioned here because of their close proximity to the kidneys. In the prairie dog, the left kidney is located farther caudad than the right. The ureters (Fig. 7) extend caudad from the hilus of each kidney to the urinary bladder, and open into the bladder on the dorsolateral surface. The urinary bladder (Figs. 7, 8) is a pear-shaped structure supported by a median and two lateral ligaments. Between the dorsal surface of the urinary bladder and the rec-

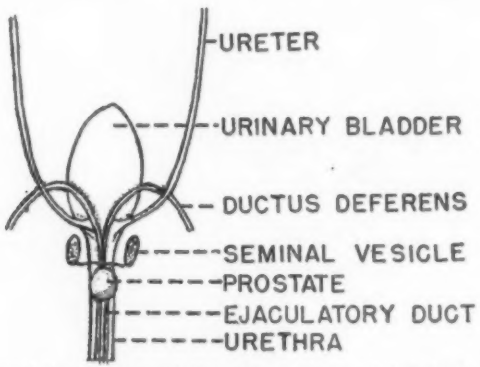


FIG. 6.—Dorsal view of the prostatic urethra, and associated glands, in the male reproductive system

tum are found the seminal vesicles (Fig. 6). In sexually inactive specimens, these are small, translucent, thread-like structures. However, in the breeding season, they become elongated, and extend cephalad beyond the urinary bladder. I could find no coagulating gland as is common among certain other rodents. Mossman *et al.* (1932), in describing the urogenital system of the Sciuridae, do not mention the gland. Hill (1937: 155) mentioned no such gland in the pocket gophers. The prostate gland is attached to the proximal part of the dorsal surface of the urethra (Fig. 6). The ducti deferentia (Figs. 6, 7) from the testes (Fig. 7) loop over the ureters, and appear to enter the prostate gland. Actually, they pass ventral to the prostate, join with the ducts of the seminal vesicle, and form the ejaculatory ducts; the latter open into the urethra proximal to the glans penis. The urethra (Fig. 7, 8) continues caudad from the bladder to the open V-shaped area between the origins of the two M. ischiocavernosa. This area is covered by the corpus spongiosum; the urethra runs through the corpus spongiosum to the dorsal side of the penis where it opens just proximal to the glans penis. Dorsal and anterior to the corpus spongiosum are found the bulbourethral or Cowper's glands (Fig. 7). In sexually inactive specimens, these glands are much smaller than the corpus spongiosum. The corpora cavernosa penis, arising from the point of attachment on the caudal borders of the ischia, extend along the M. ischiocavernosa, where they unite to form the bulk of the penis. Shortly before the penis becomes external, it is bent so that upon emergence from the body proper it is directed ventrocaudad.

In all adult male specimens taken during a period of sexual quiescence, I have found the testes to be abdominal. Each testis is supported by the mesorchium and has a well-developed gubernaculum (Fig. 7). The scrotal sac is well developed in contrast to that found in the pocket gophers (Hill 1937: 155). The epididymis is composed of the usual three parts: caput, corpus, and cauda epididymis. These areas vary in size according to the sexual activity of

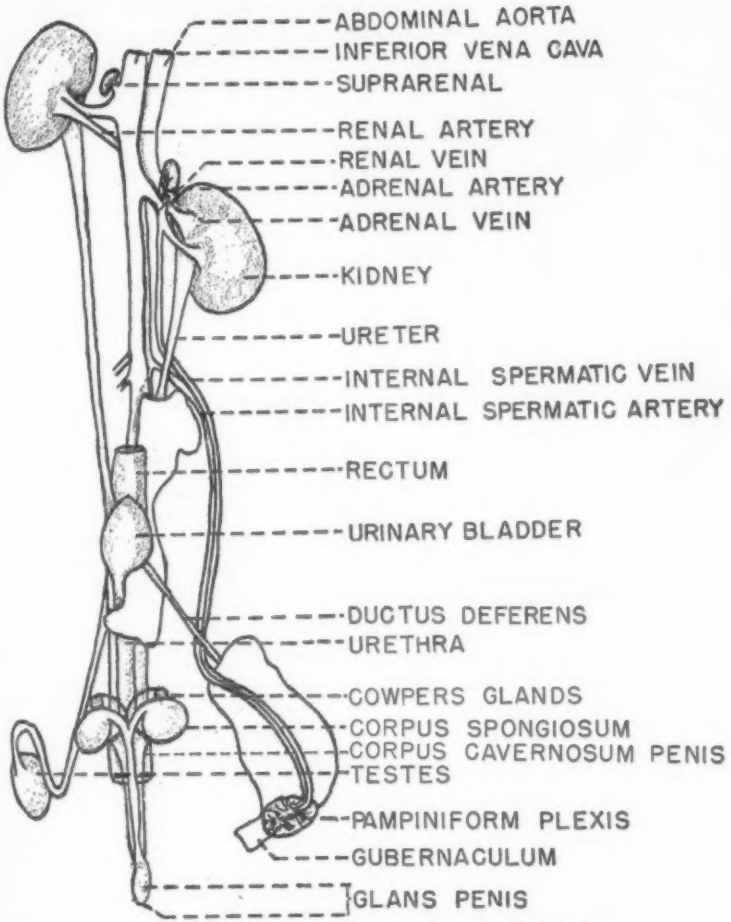


FIG. 7.—Ventral view of the male urogenital system

the animal. The ductus deferens emerges from the cauda epididymis, and runs to the urethra as described above.

Female.—In adult females, the kidneys (Fig. 8) do not differ greatly in position from those found in the male. Slight differences were found in measurements, but these may be due to sampling error. The ovaries (Fig. 8) in immature animals are smooth, and do not show the hillocks characteristic of the sexually-active adult female. The mesovarium is continuous

anteriorly with the body wall. The infundibulum of the uterine tube (Fig. 8) opens into the bursa on the lateral side opposite the ovary, and fimbriae partly cover the mouth of the bursa. From here the uterine tube extends from the medial wall of the bursa to the floor and thence to the anterior end of the ovary. From the anterior end of the ovary it is supported by

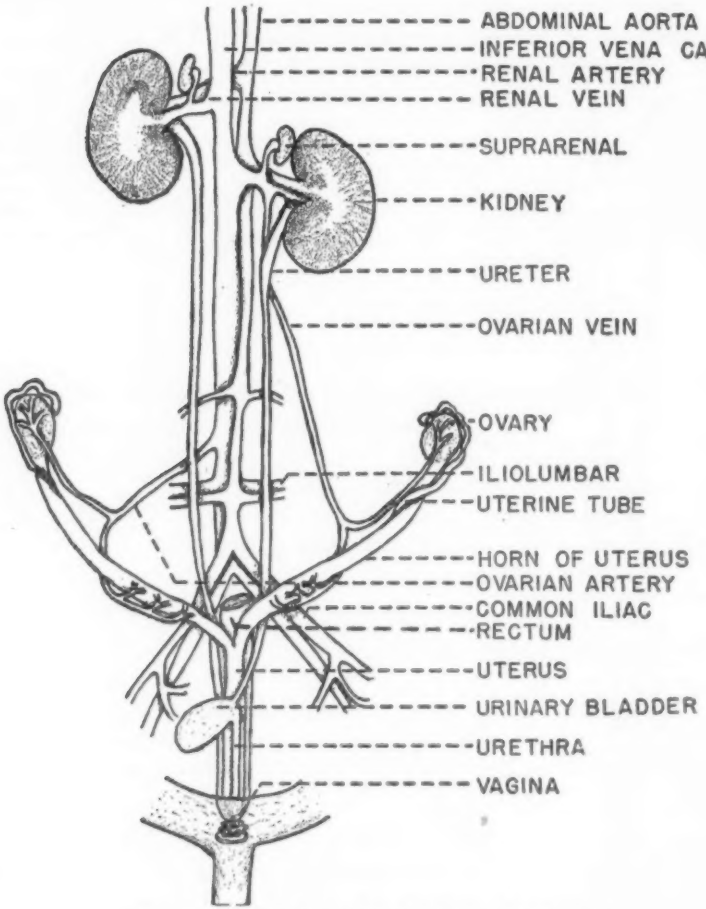


FIG. 8.—Ventral view of the female urogenital system

the mesosalpinx, and is highly coiled before entering the cornu of the uterus (Fig. 8). The mesovarium, mesosalpinx, and mesometrium form the broad ligament (ligamentum latum). The round ligament (ligamentum rotundum) extends from the middle of the broad ligament to the body wall, but at a right angle to the latter. The uterine horns extend approximately 40 mm. from the posterior tip of the ovary to their point of convergence dorsal to the urinary bladder. At the point of convergence the body of the uterus is formed (Fig. 8), which continues an average of 21 mm. caudad to its opening into the vagina.

The urinary bladder, beyond the point where it receives the ureters on its dorsolateral surface, continues caudad a short distance before giving rise to the urethra. From the urinary bladder caudad to its external opening, the urethra measures approximately 11 mm.

DISCUSSION OF RESULTS

Members of the prairie dog genus (*Cynomys*) are generally considered to represent one of the more primitive stocks of Nearctic sciurids. The details of their anatomy should be important in comparative studies of more advanced rodents. The most important results from this study are as follows:

Hill (1937: 161) placed particular emphasis on the fact that the left lung of *Thomomys* is unilobed rather than bilobed. He also considered this to be characteristic of members of the suborder Myomorpha, and inferred that the left lung of all sciuromorph rodents was subdivided. He used this feature of the anatomy of the pocket gopher, among others, as a basis for arranging the superfamily Geomyoidea under the suborder Myomorpha. If the majority of the members of the suborder Sciuromorpha have a compound left lung (*fide* Hill), and *Cynomys*, certainly a sciuroid, has a single left lung, it would appear that the value of this character has been over emphasized. Hill (1937: 162) also considered the condition of the urethra of the female being separate from the vagina as diagnostic of myomorph rodents. My investigations show this condition to be present in the whitetail prairie dog (*Cynomys leucurus*). The present findings point to the need for further study of these details in other genera of rodents. The presence of two circumvallate papillae on the dorsum of the tongue of the prairie dog is, however, different from the condition Hill (*op. cit.*) reported in the genera *Thomomys* and *Geomys*, where only one such papilla is found. A single circumvallate papilla is also found in muroids (Hill, *op. cit.*), and, in this respect, the geomyids are similar to the muroids.

The caecum probably acts as a reservoir for food materials, and some water and nutrient materials may also be absorbed there. Because the orifice of the ileum is in the septum of the iliocaecal valve, it is entirely possible that food material from the small intestine may enter either the ampulla coli directly without passing into the caecum, or may pass into the caecum, there to be retained temporarily. What conditions might govern the utilization of these apparently alternate routes are unknown.

Chalmers Mitchell and A. B. Howell have carried out investigations on the intestinal tract of mammals—Mitchell (1905) from an embryological and anatomical standpoint, Howell (1926) from the gross anatomical aspects. Mitchell divides the small intestine of rodents into duodenum and Meckel's tract. From the standpoint of gross anatomy this subdivision would seem applicable to the prairie dog. From a histological standpoint, however, the small intestine can easily be separated into three distinct regions: duodenum, jejunum, and ileum.

The two ejaculatory ducts of the male reproductive system arise as separate ducts, and remain so until they join at the glans penis. Since the paired condition of the female uteri is a more or less primitive characteristic in placental mammals, it would also seem possible that the paired ejaculatory ducts of the male are indicative of primitiveness.

The absence of the exorbital and intraorbital lacrimal glands may be correlated with the large size of the Harderian gland, i.e., the oily secretion of the Harderian gland may be used to moisten the eye, in place of the lacrimal secretion.

In the pancreas of many animals there is often only one main duct, and this enters the ampulla of Vater in common with the bile duct. In the pancreas of the prairie dog, I located many ducts, some of which entered in common with the bile duct, but the majority emptied directly into the duodenum. The purpose of the numerous pancreatic ducts is not known.

SUMMARY

Because the prairie dog (*Cynomys leucurus*) is generally considered to be a primitive sciurid, and its structure, therefore, is of special significance for its phylogenetic implications, it seemed advisable to undertake a study of the gross

anatomy of its viscera. From this study I hoped to find some evidence that would be of value to the taxonomist, and materially add to the knowledge of primitive sciurid anatomy. I have made comparisons based on published accounts of the anatomy of the woodrat, pocket gopher, kangaroo rat, and the albino rat, and where significant differences were evident, I have attempted some interpretations. Although the study of visceral anatomy is still a young science in reference to phylogeny, such students as Hill (1937) and Mossman *et al.* (1932) have already made definite contributions along these lines.

In obtaining specimens for this study, I have tried to sample the various populations throughout the range of *Cynomys leucurus* in Utah. In all, I have dissected 16 prairie dogs.

The following structural conditions of the visceral anatomy of the prairie dog are of particular significance:

1. Unilobate left lung.
2. Small intestine divisible into duodenum, jejunum, and ileum, in place of duodenum and Meckel's tract.
3. Caecum large, with the ileum entering in an unusual position.
4. Paired ejaculatory ducts.
5. Urethra of the female completely separate from the vagina.
6. Two circumvallate papillae on the dorsum of the tongue.
7. Many pancreatic ducts.

It is evident that further investigations on other rodents are necessary to determine the phylogenetic significance of certain structures, notably the lobation of the lungs, relations of the female urethra, and the number of circumvallate papillae.

Acknowledgments.—I should like to acknowledge with thanks the co-operation extended to me by the Department of Vertebrate Zoology, University of Utah, in the preparation of this thesis. In particular, Dr. Keith R. Kelson (Museum of Natural History, University of Kansas) and Dr. Stephen D. Durrant have been most helpful. To Messrs. Keith R. Kelson, Clifton Greenhalgh, Fred Reynolds, Dale C. Dearden, and Robert Pendleton, I wish to extend thanks for their aid in collecting specimens.

LITERATURE CITED

Cates, E. C. 1927. Notes concerning a captive prairie-dog. Jour. Mamm., 8: 33–37.

Greene, Eunice C. 1935. Anatomy of the rat. Trans. Amer. Phil. Soc., Philadelphia, 27: 370 p.

Hill, J. E. 1937. Morphology of the pocket gopher mammalian genus *Thomomys*. Univ. Calif. Publ. Zool., 42(2): 81–172, 26 figs.

Howell, A. B. 1926. Anatomy of the woodrat. Williams & Wilkins Co., Baltimore. 225 p.

Hollister, N. 1916. A systematic account of the prairie dog. U. S. Dept. Agr., N. Amer. Fauna, 40: 1–37.

Hunt, H. R. 1940. A laboratory manual of the anatomy of the rat. Macmillan Co., New York. 123 p.

Johnson, G. E. 1927. Observations on young prairie-dogs (*Cynomys ludovicianus*) born in the laboratory. Jour. Mamm., 8: 110–115.

KENDALL, J. I. 1947. Microscopic anatomy of vertebrates. Lea & Febiger, Philadelphia. 354 p.

MAXIMOW, A. A., AND W. BLOOM. 1947. A textbook of histology. W. B. Saunders Co., Philadelphia. 695 p.

MIDGLEY, E. E. 1937. The visceral anatomy of the kangaroo rat, *Dipodomys*. (Unpublished masters thesis, University of Utah, 1937). 62 p.

MOSSMAN, H. W., J. W. LAWLAH, AND J. A. BRADLEY. 1932. The male reproductive tract of the Sciuridae. Amer. Jour. Anat., 51: 89–155.

MITCHELL, P. C. 1905. On the intestinal tract of mammals. Trans. Zool. Soc. London, 17: 438–536.

ROBINSON, ARTHUR. 1921. Cunningham's textbook of anatomy. William Wood and Co., New York. 1593 p.

SETON, E. T. 1926. The prairie-dogs (Cynomys ludovicianus) at Washington zoo. Jour. Mamm., 7: 229–230.

SMITH, P. E., AND W. M. COPENHAVER. 1935. Bailey's textbook of histology. Williams and Wilkins Co., Baltimore. 781 p.

STOCKARD, A. H. 1929. Observations on reproduction in the white-tailed prairie-dog (Cynomys leucurus). Jour. Mamm., 10: 209–212.

———. 1935. Studies on the female reproductive system of the prairie-dog *Cynomys leucurus*. Papers Michigan Acad. Sci. Arts, Let., 20: 725–736.

Department of Zoology, University of Massachusetts, Amherst, Mass. Received January 4, 1952.

AGE CLASSES, REPRODUCTION, AND SEX RATIOS OF WYOMING BEAVER

BY DALE J. OSBORN

The aim of this study was to obtain information concerning the age classes, reproduction, and sex ratios of the beaver in Wyoming which might be of value in their management and propagation. The material presented was submitted to the Department of Zoology and Physiology, University of Wyoming, in partial fulfillment of the requirements of the Master of Science degree in 1949. The work was done under the direction of Dr. Reed W. Fautin. Beaver were obtained through the cooperation of the Wyoming Game and Fish Department and from various private trappers, and the photographs were taken by Bruce Christian of Laramie, Wyoming. The help of these individuals is greatly appreciated. Mrs. Dale J. Osborn deserves special credit for her aid in the preparation of the manuscript.

The status of the subspecies of beavers in Wyoming is uncertain because no extensive taxonomic studies have been made. The problem is becoming more complex due to the fact that each year more beaver are being distributed by transplanting agencies. The ranges of those subspecies which have been recognized in adjoining states probably extend into and possibly overlap in Wyoming.

The majority of the beavers obtained for this study came from Albany and Laramie counties in southern Wyoming. These are possibly of the subspecies *Castor canadensis concisor* described by Warren and Hall (1939) as are those

specimens obtained from Sublette County. A few specimens from Lincoln County were taken from the Snake River drainage and probably belong to the subspecies *Castor canadensis taylori* (Davis, 1939).

According to the Wyoming Game and Fish Commission (1949), the total number of beavers trapped in the state during the years from 1941 to 1948 numbered 68,900 and were valued at $1,807,972.47. The beaver may be a valuable asset to the state of Wyoming not only as a fur bearer, but also in soil and water conservation and in improving or providing habitats for trout, muskrat, moose, mink, and waterfowl.

MATERIALS AND METHODS

One hundred and eighty-eight beaver carcasses and 31 live specimens were examined. They were trapped from April 5 to November 21, 1948. These specimens were obtained from the following areas: Albany County—Big Laramie River and tributaries in the vicinity of Woods Landing, Little Laramie River and tributaries in Centennial Valley, tributaries to Lodge-pole Creek in the Pole Mountain Division of the Medicine Bow National Forest, and a tributary to the Medicine Bow River in the vicinity of Rock River; Laramie County—Lodge-pole Creek north of Cheyenne; Lincoln County—Tributaries to the Snake and Bear Rivers in the vicinity of Afton; Sublette County—Tributaries to the Green River west of Big Piney.

A routine procedure was followed in recording the data for each specimen examined. Two different types of data sheets were used for male and female specimens. Weights and measurements were recorded together with reproductive data for each individual. Weights and volumes were recorded for the testes and seminal vesicles in the male specimens. Also recorded were the measurements, weights, and volumes of the ovaries; the number, weight, and measurements of fetuses together with data on sex and development; and the number of resorbed embryos in pregnant females and placental scars in post-partum females. All reproductive material was preserved in ten per cent formalin.

A sample of 76 skulls from the 188 carcasses and the bacula of all male beaver were cleaned numbered, and measured.

AGE CLASSES

Criteria.—An attempt was made to place the beavers examined into various age classes. Unfortunately, no material from beavers of known ages was available for comparison with that examined. Agreement on criteria for estimating the age of beaver was found to be lacking in the literature.

In a systematic study of beaver, Taylor (1916) discusses various cranial changes due to age. He found that the degree of approximation of the temporal ridges and the degree of development of the lambdoidal crest are indicative of age. He also found that the size of the cranium and the condition of certain sutures, whether open or closed, constituted the chief basis for age determination. He also observed a change in shape of the interparietal, frontal, and palatine (in ventral view) bones from younger to older skulls. Benson (1933) regards the cranial ridges as of little value in age determination and considers the degree of closure of the suture between the basioccipital and basisphenoid as a better criterion. Friley (1949b) used bacula measurements to separate a series of specimens of Michigan beaver into age classes.

From the data collected in this study it appeared that a more satisfactory method could be developed using both male and female specimens. The criteria used were obtained by a systematic examination of a random sample of 76 skulls from the 188 specimens collected.

This series of skulls was first arranged in order of the smallest to the largest by total dorsal length measurement. A gross examination was then made of the entire series, considering all of the above criteria, in an attempt to differentiate groups of individuals at

similar stages of development. The arrangement showed that the series tended to fall into three developmental groups. However, there were certain skulls which were difficult to fit into one particular age class.

A rearrangement was made using the greatest zygomatic width as the basis of the series order. This gave a clear indication of developmental grouping. Shifting a few skulls to correspond with others of like development revealed three fairly distinct age classes, which were designated as juvenile, subadult, and adult.

Other criteria, in addition to total dorsal length and zygomatic widths, which proved most useful in defining these age classes were the degree of approximation of the temporal ridges, the development of the median sagittal crest, and the degree of development of the lambdoidal crest. The changes in the outline of the frontals, interparietal, and palatine did not appear to follow a distinct enough pattern to be useful in differentiating the beaver into groups of similar development. The degree of closure of the suture between the basioccipital and basisphenoid did not agree with other, apparently more sound, criteria.

Those specimens whose skulls were prepared and measured will be referred to as group "A" and the remaining specimens will be referred to as group "B".

Class 1. Juveniles.—This class was assumed to include beaver approximately one year of age. About thirty per cent of these skulls had permanent premolars which were not yet functional. Milk premolars were still present in only one of these skulls. The general appearance of the skull surface was smooth. The temporal ridges were wide apart and indistinct posteriorly. Their degree of approximation varied from a point just anterior to the mid-dorsal section of the developing lambdoidal crest anteriorly to a point about one-half the length of the interparietal. The lambdoidal crest was low and undeveloped (Plate I). The skull measurements are given in Table 1.

Class 2. Subadults.—This class was assumed to include individuals approximately two years of age. The general appearance of the skull surface was slightly rough. These skulls were larger and heavier than those in Class 1 and the temporal ridges were more distinct and closer to the median line than in the juvenile skulls. The degree of approximation of these ridges varied from a point about one-half the length of the interparietal to a point just beyond the anterior margin of the interparietal.

The median sagittal crest had begun to develop anterior to the point of approximation of the temporal ridges. The lambdoidal crest was well developed with posterior flares lateral to the mid-dorsal point (Plate I). Closure of the suture between the basioccipital and basisphenoid had begun in a few skulls. The skull measurements are given in Table 1.

Class 3. Adults.—This class was assumed to include individuals three years of age and older. These skulls were much heavier and had a more massive appearance than those of the preceding classes. The temporal ridges were very distinct and more medial in position than in the subadult class. The degree of approximation of these ridges varied from a point just beyond the anterior margin of the interparietal to the posterior margin of the frontals, at which point they fused with the sagittal crest. The median sagittal crest had developed from the point of approximation of the temporal ridges to the posterior margin of the frontals even on those skulls on which the degree of approximation did not extend to the posterior margin of the frontals. The lambdoidal crest was prominently developed, higher and more pronounced than in the subadult class (Plate I). Cranial measurements are given in Table 1.

All degrees of closure of the suture between the basioccipital and the basisphenoid occurred in this class. In some skulls there was no evidence of closure having begun, while in others the closure was complete. In the case of the oldest individuals there was complete closure of all sutures.

Measurements and weights of group "A".—Data on cranial measurements of group "A" are presented in Table 1. The zygomatic width and total dorsal length measurements indicate a more uniform growth pattern than other measurements which were taken and are considered to be of greater value in age determination.

External measurements and weights of group "A" are presented in Table 2. The skinned

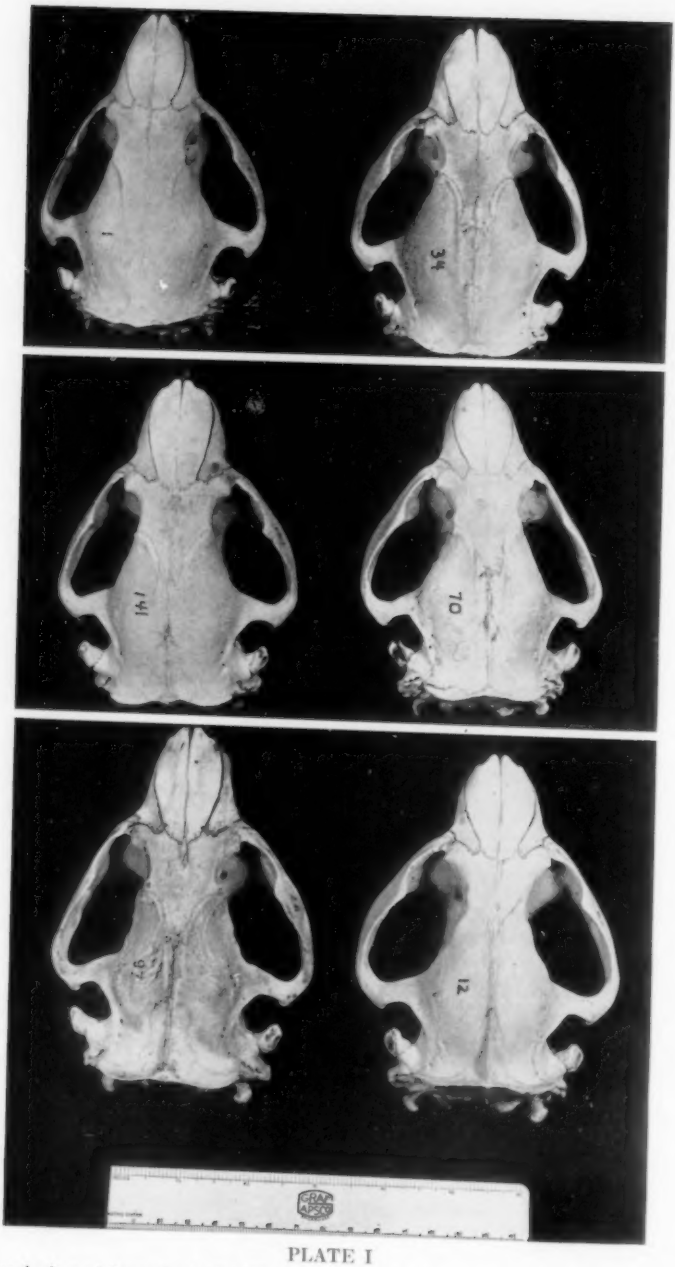


PLATE I

Dorsal view of juvenile skulls (Upper); subadult (Middle); and adult (Lower).

weights of the juvenile class averaged 84.84, the subadults 86.96 and the adults 86.92, per cent of the actual weights.

The juvenile age class was more easily separated from the subadult than were subadults from adults on the basis of developmental changes in cranial characters. In comparing cranial measurements and external measurements and weights, the youngest age class is more clearly defined than the older age classes. Slower growth rate in the older individuals is probably one reason why older age classes are more difficult to separate. The length of the season of birth in beaver and the individual variability in growth rates are other possible reasons for the difficulties involved in segregating individuals of similar age. This is in agreement with the work of Simpson and Roe (1939) who have collected data on the growth and development of various other species of mammals.

Age classes of group "B".—The age classes of group "B" (specimens without skulls) were determined by carefully comparing the measurements and weights of each individual within the group with the measurements and weights of group "A". The measurements which proved most useful were the length of the tail vertebrae, length and width of the scaly part of the tail and total length. Skinned weights were also used.

TABLE 1.—*Cranial measurements (mm.) giving means, extremes, and standard deviations for age classes in group "A"*

AGE CLASS	JUVENILE	SUBADULT	ADULT
No. individuals	23	19	26
Greatest zygomatic width	77.49 ± .75 (67.7–83.0) S.D. = 3.61	87.32 ± .66 (83.4–92.8) S.D. = 2.90	96.81 ± .99 (87.6–107.5) S.D. = 5.03
No. individuals	23	22	31
Dorsal length of skull	107.76 ± .88 (97.3–114.3) S.D. = 4.23	120.5 ± .78 (112.5–127.7) S.D. = 3.64	131.07 ± 1.03 (121.9–145.4) S.D. = 5.76

Data on the external measurements and weights of the age classes of group "B" are presented in Table 2. The means and extremes of the various measurements within each of these classes in group "B" compared very favorably with those in group "A". Consequently, the age classes within group "B" are considered to be as reliable as those in group "A".

The skinned weights of the juvenile class averaged 84.22, subadults 84.65, and adults 85.65, per cent of the actual weights. These values are very close to those for group "A" as given above.

Variation.—The coefficients of variation for the external measurements and weights of groups "A" and "B" are shown in Table 3. An examination of these data indicates which measurements appear to be most reliable as criteria for age determination. It will be noted that the largest percentages of variation occurred in the juvenile and adult age classes. As stated previously, the juvenile age class included all individuals approximately one year of age. Due to the prolonged period of birth in beaver, many of these individuals may have been several months younger than one year. In regard to the adult class, higher percentages here may be attributed to a few individual variants having small measurements and a few very old individuals, which were known to be present in the collection.

The baculum as a criterion for age determination.—The baculum or os penis has

TABLE 2.—*External measurements (mm.) and weights (gms.) giving means, extremes, and standard deviations in groups "A" and "B"*

Group	A	B
JUVENILES		
Number individuals	23	33
Total length	834.56 ± 11.00 (699–958) S.D. = 52.81	844.00 ± 10.39 (724–945) S.D. = 59.65
Number individuals	23	33
Tail vertebrae	374.26 ± 5.64 (298–422) S.D. = 27.08	383.97 ± 4.68 (332–430) S.D. = 26.87
Number individuals	23	33
Body length	460.30 ± 5.77 (401–536) S.D. = 27.69	460.03 ± 6.68 (354–540) S.D. = 38.16
Number individuals	23	33
Scaly tail length	220.44 ± 3.16 (181–241) S.D. = 15.19	226.00 ± 2.98 (198–259) S.D. = 17.12
Number individuals	23	33
Scaly tail width	97.87 ± 2.62 (78–128) S.D. = 12.60	100.97 ± 1.85 (82–125) S.D. = 10.61
Number individuals	18	25
Hind foot	152.67 ± 1.36 (140–164) S.D. = 5.75	154.80 ± 1.11 (143–166) S.D. = 5.56
Number individuals	22	33
Skinned weight	15.58 ± .77 (8.75–24.75) S.D. = 3.63	15.61 ± .46 (11.00–24.25) S.D. = 2.66
SUBADULTS		
Number individuals	22	41
Total length	994.14 ± 7.00 (943–1064) S.D. = 32.82	994.61 ± 5.00 (931–1030) S.D. = 32.02
Number individuals	22	41
Tail vertebrae	441.14 ± 3.85 (400–469) S.D. = 18.06	442.51 ± 3.39 (346–473) S.D. = 21.70
Number individuals	22	41
Body length	551.77 ± 5.43 (506–635) S.D. = 25.47	552.10 ± 4.31 (493–633) S.D. = 27.59

TABLE 2.—(continued)

Group	A	B
SUBADULTS		
Number individuals	22	41
Scaly tail length	261.36 ± 2.95 (235–288) S.D. = 13.84	261.15 ± 1.77 (235–279) S.D. = 11.32
Number individuals	21	41
Scaly tail width	131.90 ± 1.89 (118–152) S.D. = 8.66	132.98 ± 1.54 (118–157) S.D. = 9.85
Number individuals	17	30
Hind foot	169.94 ± 1.41 (162–177) S.D. = 5.82	168.37 ± 1.05 (154–180) S.D. = 5.73
Number individuals	22	40
Skinned weight	26.86 ± .69 (20.00–33.50) S.D. = 3.22	26.48 ± .62 (20.00–36.25) S.D. = 3.89
ADULTS		
Number individuals	30	39
Total length	1076.00 ± 8.27 (1002–1167) S.D. = 45.32	1085.82 ± 7.52 (1000–1200) S.D. = 46.90
Number individuals	30	37
Tail vertebrae	475.83 ± 4.06 (440–516) S.D. = 22.17	480.24 ± 3.41 (446–523) S.D. = 20.76
Number individuals	30	37
Body length	599.70 ± 5.45 (552–653) S.D. = 29.86	606.03 ± 7.38 (506–750) S.D. = 44.86
Number individuals	30	39
Scaly tail length	280.73 ± 2.66 (258–318) S.D. = 14.60	283.44 ± 2.14 (260–310) S.D. = 13.34
Number individuals	30	39
Scaly tail width	152.10 ± 2.71 (130–200) S.D. = 14.86	149.62 ± 1.95 (128–171) S.D. = 12.17
Number individuals	26	35
Hind foot	177.08 ± 1.36 (156–186) S.D. = 6.92	178.13 ± .92 (165–190) S.D. = 5.47
Number individuals	31	32
Skinned weight	36.48 ± 1.00 (25.00–47.75) S.D. = 5.58	34.42 ± .92 (26.75–45.50) S.D. = 5.23

recently received much attention as a criterion for age determination in various mammals. Baumgartner and Bellrose (1943) used the shape of the baculum as a basis for distinguishing subadult and adult muskrats. Friley (1949a) age-grouped a series of river otter bacula on the basis of total length, weight, volume, and shape. Later Friley (1949b) separated a group of beaver into yearling, two and three year old, and four year old age classes on the basis of skull and bacular measurements. He used some different skull measurements from the

TABLE 3.—*Coefficients of variation of external measurements and weights for age classes in groups "A" and "B"*

AGE CLASS	JUVENILE		SUBADULT		ADULT	
	A	B	A	B	A	B
Total length	6.32	7.07	3.30	3.22	4.21	4.32
Tail vertebrae	7.24	7.00	4.09	4.90	4.66	4.32
Body length	6.02	8.30	4.62	5.00	4.98	7.40
Scaly tail length	6.89	7.58	5.30	4.33	5.20	4.71
Scaly tail width	12.98	10.51	6.56	7.41	9.77	8.13
Hind foot	3.77	3.59	3.42	3.40	3.91	3.07
Skinned weight	23.30	17.04	11.99	14.69	15.30	15.19

TABLE 4.—*Bacula measurements giving means, extremes, and standard deviations*

AGE CLASS	JUVENILE	SUBADULT	ADULT
No. individuals	26	27	25
Total length (Including curvacurvature)	25.00 ± .706 (17.5-31.9) S.D. = 3.60	31.68 ± .412 (28.1-35.9) S.D. = 2.14	33.15 ± .374 (29.5-36.0) S.D. = 1.87
No. individuals	26	27	25
Lateral diameter of base	4.61 ± .036 (2.4-6.2) S.D. = .92	6.39 ± .039 (5.4-7.5) S.D. = .20	7.13 ± .106 (5.6-8.0) S.D. = .53
No. individuals	26	27	25
Dorso-ventral diameter of base	3.62 ± .176 (1.7-5.4) S.D. = .90	5.79 ± .133 (4.4-7.1) S.D. = .69	6.67 ± .182 (4.6-8.2) S.D. = .91

ones presented here together with the head/tail, baculum length ratio, and the weight of the baculum.

Less stress was placed on the baculum in this study because of the need for criteria by which both sexes could be aged. Considerable overlap occurs between all measurements within the three age classes (Table 4). The morphology and development were also found to vary within each of the age classes. Those bacula with the largest and smallest total length and lateral basal diameter in each age class are shown in Plate II.

REPRODUCTION

Male reproductive glands.—Weights and volumes of the testes and seminal vesicles collected during the months of April and May are presented in Table 5. According to the data presented in this table, the glands of the juvenile class are very distinct from the other age classes during these months. There is evidence of reduction in size of the reproductive glands in all age classes for May as compared with those for April.

The seminal vesicles show much more regression in size from April to May than do the testes. The mean values of the weights and volumes of the seminal vesicles decreased more than 50 per cent in almost all cases. Regression of the glands does not begin in all individuals at the same time as evidenced by the variations in size during the periods indicated. The seminal vesicles indicate that the period of glandular regression in the

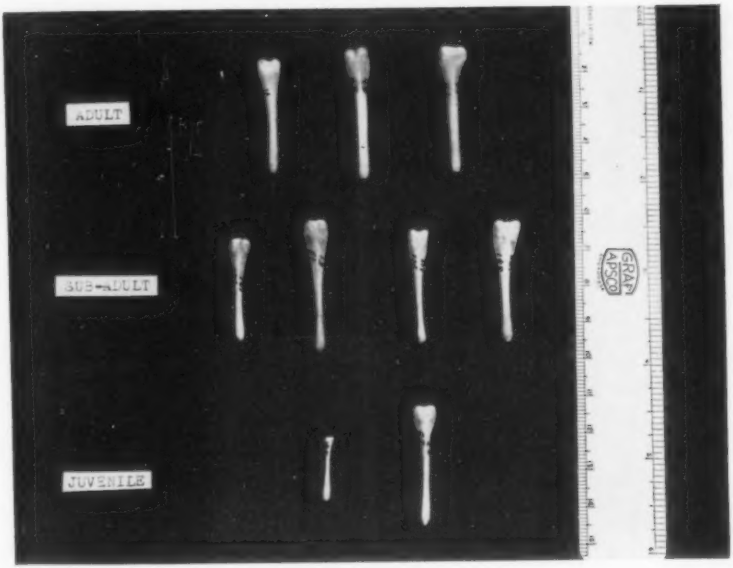


PLATE II
Bacula of beaver.

reproductive cycle of male beaver begins about the latter part of April and the first part of May. These glands are evidently of considerable importance in the beaver as indicators of the periods of the male reproductive cycle.

The positions of the testes in the beaver gave no indication of the breeding condition. No significant correlation could be found between the position of the testes and their dimensions, weights, and volumes. The testes are evidently free to move in or out of the abdominal cavity at any time. Owen (1868) remarks that in the beaver examined by him, the testes were usually lodged in the subcutaneous depressions between the castor glands. He also states that the usual wide opening of the tunica vaginalis permitted easy return of the gland into the abdomen. During the summer of 1948, sixteen male beaver were palpated to determine the position of the testes. Of the 16 beaver examined, 53.2 per cent of the testes were descended, 28.1 per cent were abdominal, and 18.7 per cent were inguinal in position.

TABLE 5.—*Means and extremes of weights and volumes of male reproductive glands for April and May, 1948*

	JUVENILE	APRIL	MAY
Testes	Number glands	16	33
	Weight (gms.)	2.98 (1.6–5.1)	2.28 (0.9–4.5)
	Number glands	16	33
	Volume (cc.)	2.88 (1.5–5.0)	2.22 (0.8–4.3)
Seminal vesicles	Number glands	8	10
	Weight (gms.)	1.03 (0.2–2.7)	0.57 (0.3–1.1)
	Number glands	8	10
	Volume (cc.)	1.18 (0.2–3.0)	0.49 (0.3–1.0)

	SUBADULT	APRIL	MAY
Testes	Number glands	12	48
	Weight (gms.)	8.32 (5.7–10.0)	5.65 (2.4–8.0)
	Number glands	12	48
	Volume (cc.)	8.12 (5.5–10.0)	5.56 (2.4–8.0)
Seminal vesicles	Number glands	11	42
	Weight (gms.)	10.33 (5.8–14.8)	2.69 (0.8–6.4)
	Number glands	11	42
	Volume (cc.)	9.54 (6.0–13.5)	2.37 (0.7–6.5)

	ADULTS	APRIL	MAY
Testes	Number glands	20	36
	Weight (gms.)	9.30 (4.0–11.4)	8.50 (4.5–12.8)
	Number glands	20	36
	Volume (cc.)	8.95 (4.0–11.0)	8.29 (4.5–12.0)
Seminal vesicles	Number glands	20	33
	Weight (gms.)	13.68 (3.9–23.3)	6.71 (1.2–19.1)
	Number glands	20	33
	Volume (cc.)	12.58 (3.5–23.0)	6.83 (1.0–17.5)

Ovaries.—Measurements, weights, and volumes of the ovaries were determined for the females collected. These data are not presented as they were apparently of little value in comparing age classes and reproductive cycles. No attempt was made to count corpora lutea or to section the material for histological examination.

Breeding ages.—No evidence of reproduction was found in the 24 female juvenile beaver examined. The first evidence of reproduction occurred in individuals of the subadult age class. Of the 33 subadult females examined 21.21 per cent were found to be pregnant or to have given birth to young. Four of these were pregnant and the other three were postpartum. Of the 39 adult specimens 89.45 per cent were found to be reproducing females. Eighteen of these were pregnant and 16 had given birth to young. These data seem to indicate that female beaver do not begin breeding until the second breeding season following birth and that the majority of them do not breed until the third breeding season following birth.

An examination of 72 female carcasses by Benson (1936) revealed comparable findings on the breeding age. According to him, no evidence of breeding was found in yearling females and there was some indication that some two-year-olds do not reproduce. Grinnell, *et al.* (1937) and Weaver (1948) are similarly of the opinion that the breeding age for some females is two years, but three years is more common. Warren (1927) and Show, *et al.* (1947) share the opinion that females begin breeding at two years of age. Bradt (1938) and Patton (1925) stated that three years is the minimum breeding age. Bradt (1947) considers it to be two and a half years of age. Fritzsche (1931) suggested that beaver in Germany begin breeding at two years of age and occasionally at a little over one year of age. Bailey (1922) concluded that breeding begins at one year of age because he often observed one or two embryos in females weighing 25 to 30 pounds. He also states that some individuals may not breed the first year. Grasse and Putnam (1950) claim to have trapped a yearling female with one kit. This beaver weighed 23 pounds. They maintain that two years is the conventional breeding age and that beaver usually mate as late two-year-olds and have young when they are three.

In this study 56.2 per cent of the skinned weights of the subadult females examined were found to be 25 pounds or less. The actual weights of these specimens would not be over 27.6 pounds according to the percentages of skinned to actual weights given for the subadult class. The reproducing yearlings mentioned above by Bailey (1922) and Grasse and Putnam (1950) may have been small second year females.

Litter sizes.—The size of the litter was determined from the number of fetuses and placental scars present in the females examined. Placental scars were easily counted in most cases although there was a regression in their size from May to August.

The data presented in Table 6 indicate that the older females produce larger litters than the younger, but this does not necessarily hold true for every individual. Three of the adult females contained only one fetus or placental scar each. Similar data have been obtained by other investigators. Bailey (1927) found that younger females produce from one to two young while the older females produce from four to six. Fritzsche (1931) states that the first birth is usually two to three young and old females give birth to six and even eight.

The average litter sizes and ranges (Table 7) were found to be slightly smaller in comparison with the averages and ranges in litter sizes recorded by other investigators in various parts of the United States. One exception was in the observations of Patton (1925) where the average litter size was three.

Resorption of embryos.—Embryos which were being resorbed were easily distinguishable in the pregnant females in which they occurred. The importance of resorptions in reducing litter sizes is evident in both age classes. Resorptions were present in 27.27 per cent of the 22 pregnant females. Two resorptions were found in one subadult female, reducing her litter size from 4 to 2. Four of the adult females had one resorption each. One adult had 5, which reduced her litter size from 6 to 1.

The only other observation of resorption of embryos in beaver has been recorded by Hammond (1943). He described the three small placental enlargements which he found in

two pregnant females as embryos possibly being resorbed. From the number of resorptions observed in this study, they are evidently not uncommon in beaver and may have been overlooked by other investigators. Scars from resorptions may have been present in some of the post-partum females, but in such a late stage in the reproductive cycle they would be difficult to distinguish from the placental scars. This fact may account for the differences in litter sizes as determined from fetal and placental scar counts. The average litter sizes were always greater when determined by placental scar counts (Tables 6, 7).

Development of fetuses.—Various stages of fetal development were found, ranging from small and naked to complete development prior to parturition. One of the smallest fetuses, which was collected April 11, had a total length measurement of 123.0 mm. and weighed

TABLE 6.—*Averages and ranges of litter sizes in subadult and adult females*

	FETUSES	PLACENTAL SCARS	FETUSES AND PLACENTAL SCARS
Number females	4	3	7
Subadult	2.25 (2-3)	1.33 (1-2)	1.86 (1-3)
Number females	18	16	34
Adults	3.05 (1-5)	3.75 (1-6)	3.38 (1-6)

TABLE 7.—*Litter sizes as determined by numbers of fetuses and placental scars*

FETUSES	FREQUENCY		PLACENTAL SCARS	FREQUENCY		FETUS AND PLACENTAL SCARS	FREQUENCY	
(No.)	(No.)	(%)	(No.)	(No.)	(%)	(No.)	(No.)	(%)
1	2	9.1	1	3	15.8	1	5	12.2
2	8	36.4	2	2	10.5	2	10	24.4
3	5	22.7	3	5	26.3	3	10	24.4
4	4	18.2	4	5	26.3	4	9	21.9
5	3	13.6	5	2	10.5	5	5	12.2
			6	2	10.5	6	2	4.9
Average/Female 2.91			Average/Female 3.37			Average/Female 3.12		

54.8 grams. The largest fetus, which was collected May 21, had a total length measurement of 348.0 mm. and weighed 614.5 grams. Many variations in development occurred between these two extremes. The hair begins to develop on the top of the head and progresses posteriorly, with an increase in size of the fetus, over the shoulders and back. The last area to become furred is the belly.

The tails of all fetuses were well formed, had the typical shape of the adults', but showed no evidence of scaliness until the hair pattern was completely developed. In all cases the vibrissae were visible, the "combing claw" on the hind foot was evident, and the hind toes were webbed.

Individual fetuses that were considered as being almost full term ranged in total length from 292.0 mm. to 348.0 mm. The scaly tail length ranged from 59.0 to 82.0 mm. and hind foot from 52.0 to 72.0 mm. Weights ranged from 387.9 grams to 614.5 grams. The individuals

within four of the eight litters considered as being almost full term averaged over one pound (453.59 grams) each. According to the observations of Shadle (1930), Grinnell, *et al.* (1937), Bradt (1939), Miller (1948), and Guenther (1948), the average weight of the individuals in a litter at birth is about one pound. Krüger (1948) states that the young weigh 500 to 550 grams at birth in Finland.

There was considerable variation in the size of individuals within the same litter in some cases. In litters in which three or more fetuses were present in one uterine horn, the most anterior was usually the smallest. An example of extreme variation in sizes of littermates occurred in one litter. There were four individuals in this litter and all were in the left horn of the uterus. One, which was anterior in position, had a total length measurement of 205.0 mm. and weighed 181.5 grams. Another, which was most posterior in position had a total length measurement of 256.0 mm. and weighed 380.5 grams.

Period of birth.—An attempt was made to estimate the length of the period of births from the data obtained on collection dates of post-partum and pregnant females and the degree of development of fetuses taken from the pregnant females.

No full term fetuses were collected in April. The litters from pregnant females collected in April were either naked or with short hair over the entire body. One of the smallest fetuses taken in April was collected April 11. It weighed 54.8 grams. The largest fetus collected in April was collected April 18. It weighed 380.5 grams.

The first full term female was collected on May 1. The average weight of the individuals of the litter taken from this female was 512.6 grams. Seven other females with approximately full term fetuses were collected between May 1 and May 21. The average weights of the individuals of these litters ranged from 425.18 to 544.85 grams. The largest full term fetus, collected on May 21st, weighed 614.5 grams. The average weight of the fetuses of this litter was 534.14 grams. One female, collected on May 24, contained a fetus which was approaching full term and weighed 317.8 grams.

The first post-partum female was collected on May 1. The uterus of this female was shrunken and the placental scars were small, indicating that parturition had occurred quite some time before her capture. Twelve additional post-partum females were collected during the month of May. Female number 153, collected on May 24 and another collected on May 29, had evidently given birth a short time prior to collection because their uteri were in a swollen condition and contained large masses of maternal tissue at the points of placentation. In many cases the placental scars found in post-partum females obtained in July were as evident as those found in females collected in the early part of May.

These data indicate that the period of birth in Wyoming beaver is quite prolonged and extends at least from the latter part of April to the early part of June, a period of at least one and a half months. However, 78.8 per cent of the post-partum females were taken during the month of May. Thomas (1943) states that the period of birth in Wyoming is known to begin as early as April 20 and to extend into June. He presents no substantiating data.

Grasse and Putnam (1950) state that in Wyoming the young are usually born between June 1 and June 20 and that litters are sometimes born later. The only data they present for such a statement is the finding of one female which had given birth prior to June 3 and the weights of kits trapped in July, September, and November.

One of the first investigators to report on the variability of the period of birth in beaver was Willey (1914). He observed that there was a considerable variation in the stages of development of embryos observed on a given date during the season of reproduction. Mertens (1928), in Germany, reported seeing very small beaver in July and stated that this indicated that the period of reproduction is extended over considerable time. Tryon (1946) remarked that the large variation in weights between litters taken from the same general location indicated a fairly long breeding season.

Numerous observations have been made in various parts of the United States and in foreign countries on the period of birth in beaver. Beaver are born during May and June in Michigan (Bailey, 1927), in the Adirondacks (Johnson, 1927), and in Germany (Fritzsche, 1931). Grinnell, *et al.* (1937) state that it is difficult to determine the time when beaver are

born and judge it to be from the middle of March to the latter part of May in California, with the majority of births occurring in April. Packard (1941) reports the actual birth of a beaver in Colorado on June 16, 1940. Dalquest (1948) reports the birth of a litter in Washington during the middle of May.

Extreme variations as to the times of birth of beaver have been recorded by several investigators. Thomas (1943) reports catching a female beaver near Cheyenne, Wyoming, December 20, 1942, which showed evidence of lactating. He also records catching three of her young between December 20 and 25, 1942, which he estimates were born about November 1. They were no larger than kits taken in mid-July and averaged 21 inches (533 mm.) in total length and about five pounds in weight. Miller (1948) reports finding pregnant female beaver in Texas containing full term fetuses on February 19 and 23, 1947. Benson (1936) reports young being born in Michigan as early as March 16, while Bradt (1947) reports the birth of young as late as July in the same state. Observations of extremely late births of beaver in captivity have been made by Guenther (1948) in the state of Washington. He reports these births to have taken place on July 25 and September 11, 1947.

There is no doubt that the period of birth in beaver is extended over a relatively long period of time and that considerable individual variation in time of birth does occur in different localities. However, it is evident that the majority of births occur within a more limited period of time in any one particular locality.

Bailey (1927) has mentioned that the fact that older females breed earlier and young females breed later accounts for the extended period of birth. According to the observations of Grinnell, *et al.* (1937) the early breeders are old females and most of the late breeders are

TABLE 8.—*Sex ratios in beaver*

AGE CLASS	NUMBER INDIVIDUALS	NUMBER		SEX RATIOS	
		MALES	FEMALES	MALES	FEMALES
Juveniles	56	32	24	133	100
Subadult	63	30	33	91	100
Adult	62	29	33	88	100
All age classes	181	91	90	101	100

small young females. Little evidence for this can be found in this investigation from the data obtained relative to differences in development of fetuses from pregnant subadult and adult females and from data on the time of parturition as indicated by placental scars. Fetuses in very similar stages of development were found at approximately the same dates in females of both age classes during April and May. Of the reproducing subadult females, 42.8 per cent were found to be post-partum prior to May 29, but only 35.7 per cent of the adult females.

SEX RATIOS

Sex ratios were based on 181 specimens collected in Albany and Laramie counties and the fetuses found in the pregnant females of this group. The sex ratio of the juvenile class was found to be slightly in favor of the males and the sex ratios of the subadult and adult classes to be in favor of the females. The sex ratio for the total number examined is about equal (Table 8). The 22 litters examined contained 64 fetuses of which 36 were males and 28 were females, giving a sex ratio of 129 males to 100 females. There is only a slight difference in the ratios of the fetuses and juveniles, with a larger number of males in each group.

Bradt (1947) found that in Michigan the sex ratio at birth was 109 males to 100 females. From his observations of animals in the field and because he found the sex ratio of adults to be 108 males to 100 females he concludes that infant mortality among beaver is low. Benson (1936), also working in Michigan, found approximately equal numbers of males and females. Grinnell, *et al.* (1937) state that the sex ratio at birth is about equal.

The fact that there were more females than males in the older age classes in this study might be due to mortalities incurred among the males when fighting during the mating season, as has been suggested by Grinnell, *et al.* (1937).

ROCK CREEK BEAVER POPULATION

Forty-two of the beaver carcasses examined were taken during the period from April 7 to 25, 1948, along a ten-mile stretch of Rock Creek on the Hall and Moore (formerly Gillespie) ranches located 12.4 miles northeast of the town of Rock River, Wyoming. These beaver were considered to be undesirable by the ranchers and an attempt was made to remove as many as possible from the stream. Since this group of beaver appeared representative of the total population from this area, it is considered of value to discuss the group separately.

Population.—The population removed from this area consisted of 33.3 per cent juveniles, 26.2 per cent subadults, and 40.5 per cent adults.

Female reproduction.—None of the female juveniles were found to be reproducing, whereas 64.2 per cent of the 14 subadult and adult females were pregnant. Two, or 33.3 per cent of the six subadult females and seven, or 87.4 per cent of the eight adult females were pregnant. No placental scars were found in the non-pregnant females.

Litter sizes.—Size of the litters averaged 2.50 per female in the subadult class with a range of two to three. In adults the average litter size was 3.85 with a range of three to five.

TABLE 9.—*Sex ratios of the beaver collected from Rock Creek*

AGE CLASS	NUMBER INDIVIDUALS	NUMBER MALES	NUMBER FEMALES	SEX RATIOS MALES	SEX RATIOS FEMALES
Juveniles	14	8	6	133	100
Subadult	11	5	6	83	100
Adult	17	9	8	112	100
All age classes	42	22	20	110	100

The average litter size for both subadults and adults was 3.66 with a range of two to five. The most frequent litter sizes were three and four. Each of these litter sizes had a frequency of 33.3 per cent.

Sizes of fetuses and period of birth.—One of the smallest fetuses was number 9a, collected April 11. The largest fetus was number 31a, collected April 18. These two had total length measurements of 123.0 and 256.0 mm. and weighed 54.8 and 380.5 grams respectively. The variation in size and development between these two fetuses collected only a week apart indicates that the period of birth is prolonged even in local populations.

Sex ratios.—The sex ratio of the 33 fetuses collected from the pregnant females of this population was approximately equal. Sixteen were males and 17 were females, which gives a ratio of 94 males to 100 females. The sex ratios for the three classes and of all age classes are presented in Table 9.

SUMMARY AND CONCLUSIONS

This study was undertaken to obtain information concerning the age classes, reproduction, and sex ratios of beaver in Wyoming. One hundred and eighty-eight carcasses were obtained for this purpose. Thirty-one live specimens were also examined. The carcasses were separated into three age classes which were designated as juvenile, subadult, and adult. The age classes were established on the basis of cranial measurements and developmental changes of the skulls to-

gether with external measurements and weights. The criteria which proved most useful in age determination were total length of the skull, greatest zygomatic width, degree of approximation of the temporal ridges, the development of the median sagittal crest, and the degree of development of the lambdoidal crest. External measurements, including total length, length of the tail vertebrae, and length and width of the scaly part of the tail also proved to be useful criteria. The skinned weights were found to be of little value in age determination.

The juvenile age class was the most easily differentiated. A lesser degree of overlap occurred between the extremes of measurements and weights of juvenile and subadult age classes than between subadults and adults.

The coefficients of variation were calculated for measurements and weights of all age classes.

The baculum was found to be too variable in size and shape within the various age classes to be of any value as a reliable criterion for age determination.

The male reproductive glands showed some regression in size from April to May. The seminal vesicles were found to regress at a faster rate than the testes. The period of glandular regression in the male reproductive cycle began about the latter part of April. The mean values of the weights and volumes of the seminal vesicles decreased more than 50 per cent from April to May in all classes except the juvenile.

The position of the testes gave no indication of the breeding condition of the male as the testes are evidently free to move in or out of the abdominal cavity at any time. No significant correlation could be found between the position of the testes and their dimensions, weights, and volumes.

No juvenile females were found to be reproducing. The percentage of reproducing females in the subadult class was 21.21, and in the adult class, 89.45.

The average number of young for all reproducing females was found to be 3.12 per female. Litter sizes ranged from one to six with litters of two to four being most frequent. Older females, on the average, were found to produce larger litters than the younger females. One or more embryonic resorptions occurred in 27.27 per cent of the pregnant females.

The fetuses varied greatly in size and development. One of the smallest was 123.0 mm. in total length and weighed 54.8 grams, while the largest one measured 348.0 mm. in total length and weighed 614.5 grams.

Variation in sizes of littermates also occurred.

Hair development in fetuses began on the top of the head and progressed posteriorly over the back and down the sides. The belly was the last area to become furred. Full term fetuses were completely covered with long hair.

The period of birth was found to be quite prolonged, extending from the latter part of April to the early part of June. The majority of the births were found to occur during the month of May.

Little evidence was found to substantiate the opinions of other authors that older females breed earlier and younger females breed later.

Sex ratios were found to be about equal with 101 males to 100 females for all age classes. In 22 litters containing 64 fetuses, the sex ratio was 129 males to 100 females.

A separate study was made of a population of 42 beaver from Rock Creek. This study included population description, female reproduction, litter size, size of fetus, period of birth, and sex ratios.

LITERATURE CITED

ASDELL, S. A. 1946. Patterns of mammalian reproduction. Comstock Pub. Co. Ithaca, N. Y. 437 p.

BAILEY, V. 1922. Beaver habits, beaver control, and possibilities in beaver farming. U. S. Dept. Agr. Bul. 1078. 29 p.

———. 1927. Beaver habits and experiments in beaver culture. U. S. Dept. Agr. Tech. Bul. 21. 39 p.

BAUMGARTNER, L. L. and F. C. BELLROSE, JR. 1943. Determination of sex and age in muskrats. Jour. Wildlife Mgt., 7: 77–81.

BENSON, S. B. 1933. A new race of beaver from British Columbia. Jour. Mamm., 14: 320–325.

———. 1936. Notes on the sex ratio and breeding of beaver in Michigan. Occas. Papers Mus. Zool., Univ. Mich., 335: 1–6.

BRADT, G. W. 1938. A study of beaver colonies in Michigan. Jour. Mamm., 19: 139–162.

———. 1939. Breeding habits of beaver. Jour. Mamm., 30: 486–489.

———. 1947. Michigan beaver management. Mich. Dept. Conserv., Game Div. 66 p.

DALQUEST, W. W. 1948. Mammals of Washington. Univ. Kansas Pub., Mus. Nat. Hist., 2: 444 p.

DAVIS, W. B. 1939. The recent mammals of Idaho. Caxton Printers, Ltd., Cadwell, Idaho. 400 p.

FRILEY, C. E., JR. 1949a. Age determination, by use of the baculum, in the river otter, *Lutra c. canadensis* Schreber. Jour. Mamm., 30: 102–110.

———. 1949b. Use of the baculum in age determination of Michigan beaver. Jour. Mamm., 30: 261–267.

FRITZSCHE, R. 1931. Über Biberzucht. (Beaver culture). Pelztierzucht 7: 166–167.

GRASSE, J. E. AND E. F. PUTNAM. 1950. Beaver management and ecology in Wyoming. Wyoming Game and Fish Comm. Bul. 6: 52 p.

GRINNELL, J., J. S. DIXON, AND J. R. LINSDALE. 1937. Fur-bearing mammals of California. Univ. of California Press, Berkley, Calif. Vol. 2: 377–777.

GUENTHER, S. E. 1948. Young beavers. Jour. Mamm., 29: 419.

HAMMOND, M. C. 1943. Beaver on the Lower Souris Refuge. Jour. Wildlife. Mgt., 7: 316–321.

JOHNSON, C. E. 1927. The beaver in the Adirondacks. Roosevelt Wild Life Bul. 4: 601–641.

KRÜGER, P. 1948. The habits of the beaver and its farming. Suomen Riista, 3: 57–66. (English summary).

MERTENS, A. 1928. Über den Begattungsakt des Bibers. (Copulation of the beaver). Zeitschr. f. Säugetierkunde, 3: 60–61.

MILLER, F. W. 1948. Early breeding of Texas beaver. Jour. Mamm., 39: 419.

OWEN, R. 1868. On the anatomy of the vertebrates. Longmans, Green and Co., London. Vol. 3: 915 p.

PACKARD, F. H. 1941. Measurements of beaver at birth. Jour. Mamm., 22: 89.

PATTON, H. 1925. Raising fur bearing animals. Hardison Patton, Chicago, Ill. 466 p.

SHADLE, A. R. 1930. An unusual case of parturition in a beaver. Jour. Mamm., 11: 483–485.

SHOW, S. B., *et al.* 1947. Wildlife management. Handbook for forest officers, Region 5. U. S. Dept. Agr., Forest Service. 243 p.

SIMPSON, G. G. AND A. ROE. 1939. Quantitative zoology. McGraw-Hill, N. Y. 414 p.

TAYLOR, W. P. 1916. The status of the beavers of western North America with a consideration of the factors in their speciation. Univ. Calif. Pubs. Zool., 12: 413–495.

THOMAS, G. H. 1943. Delayed parturition in beaver. Wyoming Wild Life 8(3): 17–18.
TRYON, C. A., JR. 1946. Montana records of beaver embryos. Jour. Mamm., 27: 396–397.
WARREN, E. R., JR. 1927. The beaver: its work and its ways. Waverly Press, Baltimore, Md. 177 p.
WARREN, E. R. AND E. R. HALL. 1939. A new subspecies of beaver from Colorado. Jour. Mamm., 20: 358–362.
WEAVER, H. L. 1948. Ranching the beaver. Nat. Fur News 20 (1): 20–21, 41.
WILLEY, A. 1914. The blastocyst and placenta of the beaver. Quart. Jour. Micr. Sci., 60: 175–259.
WYOMING GAME AND FISH COMMISSION. 1949. Biennial report, 1947–1948. Cheyenne, Wyoming. 96 p.

Boston University, 725 Commonwealth Avenue, Boston 15, Massachusetts. Received January 10, 1952.

REPRODUCTION OF DEER MICE (*PEROMYSCUS MANICULATUS* AND *P. BOYLEI*) IN THE SIERRA NEVADA, CALIFORNIA

BY E. W. JAMESON, JR.

The apparently limitless diversity of form in wild animals is repeated in the abundance and variety of their life patterns; and the more similar and closely related species generally resemble one another in their biology. By observing two congeneric species living in the same region, one may see similarities and inherent differences in their life histories. When such species are of possible economic importance, this information helps to evaluate their relative significance.

In many wooded and brushy regions of the northern Sierra Nevada, California, two species of deer mice, *Peromyscus maniculatus* (Wanger) and *P. boylei* (Baird), abound. These mice were studied in Plumas County from October, 1948, until August, 1951, between elevations of 3500 and 5000 feet. The data in this paper were taken from post-mortem examinations of 1546 *maniculatus* and 830 *boylei* trapped at various seasons. Except when noted to the contrary, only gross examinations were made; weights were recorded to the nearest tenth of a gram, and, when embryos were present, their weight was subtracted to obtain the corrected body weight.

Sexual maturity.—This subject can be discussed only in a general way because the ages of the animals in this study are inferred from body weights and because sexual maturity is rather arbitrarily defined. In an investigation based on post-mortem examinations, it is rather difficult to determine the mean age at sexual maturity; but by observing the smallest mice showing signs of sexual activity one can gauge the earliest age (size) at which they reach this epoch. The presence of recent corpora lutea was used to denote sexual maturity in females, and, in males, swollen tubules of the cauda epididymides and enlarged seminal vesicles were the criteria employed. Individuals doubtless vary in this respect, and certainly mice born late in the fall do not become fecund until the following spring.

Svihla (1935: 112) illustrated the relationship between weight and age for

captive deer mice; although there might be different rates of growth for older individuals, it seems unlikely that any appreciable difference, before two months of age, would occur between captive and wild specimens.

The smallest fecund female weighed 12.6 grams (November 15, 1948); Svihla's graph indicates this individual to be between 32 and 35 days old. The vulva of this mouse was perforate, and the turgid, highly vascularized uterine horns were 2.5 mm. in diameter, denoting estrus. Another young female of approximately the same age as the above specimen (13.3 grams, September 15, 1949) carried three embryos, barely perceptible as uterine swellings, and the ovaries bore corresponding corpora lutea. A third female, also approximately the same age as the first, contained four embryos (uterine swellings, 3 mm. in diameter) and five corpora lutea. Thus it appears that the most precocious female deer mice (*maniculatus*) attain sexual maturity (and fertility) in their fifth week, or between 32 and 35 days of age. This is close agreement with the conclusions of

TABLE 1.—*Perforation of the vulva in pregnant deer mice.*

GREATEST MEASUREMENT OF EMBRYO, MM.	NUMBER OF FEMALES			
	MANICULATUS		BOYLEI	
	IMPERFORATE	PERFORATE	IMPERFORATE	PERFORATE
2	1	6	1	1
3	5	1	3	2
4	7	1	1	1
5	6	2	4	1
6-8	12	4	10	1
9-11	6	3	2	1
12-14	3	2	1	4
15-17	2	1	3	1
18-20	0	1	1	0
21-23	2	3	0	2
24-26			0	2

Howard (1949) who found that deer mice (of the subspecies *bairdi*) in central Michigan conceived as early as 32, 33, and 36 days of age; these were wild individuals, of known age, that were live-trapped at intervals.

Sexual maturity in males is reached, typically, at a slightly later age than in females. The smallest fecund male weighed 15.5 grams (June 19, 1949) and was probably from 40 to 45 days old; the testes were 7.9 mm. long, the seminal vesicles measured 6 mm. from midpoint to the lateral tip, and the tubules of the cauda epididymides were swollen with sperm. The next youngest fecund males appear to have been between 50 and 60 days old.

Perforation of the vulva.—When a female is non-fecund, the vulva is completely sealed, but during estrus there is no closure to the vagina. Following conception the condition is variable: the vulva may be perforate or imperforate at any stage in gestation with both *maniculatus* and *boylei* (Table 1). Despite this variability there is the suggestion of a pattern in the closure of the vulva follow-

ing mating: most females in the early stages of pregnancy (3–11 mm. embryos) had the vulva sealed, but there is a tendency for the vulva to be perforate in the very early and late stages. Possibly in some females it does not seal over at all during pregnancy. Students live-trapping these animals could contribute information on this point.

Ovulation and litter size.—Corpora lutea in deer mice are easily seen with a nine-power dissecting microscope; the ovary is encased in a delicate capsule that must be removed to see the condition of the ovary and to count the corpora lutea. Sometimes the ovary is embedded in fat, but such ovaries are always in

TABLE 2.—*Monthly percentages of females with fresh corpora lutea, with S. E. of percentages. Figures in parentheses indicate numbers of females examined.*

MONTH	MANICULATUS	BOYLEI
January	22 ± 7 (32)	53 ± 8 (36)
February	33 ± 8 (36)	40 ± 8 (40)
March	40 ± 7 (57)	35 ± 9 (26)
April	79 ± 5 (94)	58 ± 8 (38)
May	62 ± 7 (84)	86 ± 7 (22)
June	38 ± 7 (47)	63 ± 7 (40)
July	25 ± 9 (24)	31 ± 8 (36)
August	36 ± 8 (33)	73 ± 9 (26)
September	26 ± 5 (73)	80 ± 9 (20)
October	44 ± 6 (62)	45 ± 7 (47)
November	17 ± 5 (48)	48 ± 9 (33)
December	21 ± 5 (57)	50 ± 10 (16)

an inactive condition. Recent corpora lutea are conspicuous, vascularized swellings on the surface of the ovaries; and, as they are few in number (generally from two to five), they can be counted with accuracy. Successive sets differ sufficiently in size to cause no confusion. In the following data when two or more sets were apparent, only the most recent set was counted.

Ova are produced throughout the year, although the frequency of ovulation varies (Table 2). In most instances of winter ovulation the vagina is sealed, the oviduct is in an anestrus condition, and the males are clearly in a non-reproductive state. It is obvious that such ovulations are unaccompanied by copulation.

To verify the original identifications of these winter corpora lutea, Dr. Oliver P. Pearson kindly sectioned and studied the ovaries of two *boylei* (taken in January) and two *maniculatus* (one trapped in January and one in February). All the ovaries contained small to medium-sized follicles and large, fresh corpora lutea; but in only one individual, the *maniculatus* taken in February, 1950, was the oviduct as in estrus.

Sterile cycles have been observed in other wild mice, but in the previously published instances, these cycles have occurred just at the onset of the breeding season or immediately after puberty. Brambell and Hall (1939: 136) found that *Microtus agrestis* may not always become pregnant at the first estrus, but may go through one or more diestrus cycles. Brambell and Rowlands (1936: 85) observed as many as four or perhaps more sterile cycles in *Clethrionomys glareolus*; these cycles were accompanied by ovulation and occurred at the beginning of the breeding season.

Such sterile cycles as observed in the present study seem to indicate that the occurrence of winter breeding is a rather relative affair: that is, there appear to be present some stimuli for reproduction even though the mice observed in this study did not attain fertility throughout the year. Although this phenomenon may be characteristic of deer mice, it is more likely a reflection of the environment; winter ovulation was observed in *Microtus longicaudus* and *Clethrionomys californicus* taken in the same traplines with the deer mice. The coniferous forest in which this study was made is roughly intermediate between the humid, western slope of the Sierra Nevada and the arid, open, flat environment immediately east of the mountains. The latter area is essentially similar to the dry, sagebrush region of eastern Washington in which Scheffer (1924) observed that *maniculatus* bred throughout the year.

Although ovulation was observed in every month in both species of deer mice, there are vernal and autumnal increases in the frequency with which ova are produced. In *maniculatus* the spring peak is earlier, the autumn peak later, and the summer lull longer than in *boylei* (Table 2). The number of ova per set in *maniculatus* increases seasonally as does the frequency of ovulation, but there is no apparent pattern in *boylei* (Table 3). Among mammals generally the number of ova shed at any one time is greater in larger individuals of a particular species. This is certainly true in *maniculatus* (Table 4), in which heavier mice are probably the older ones. Very young females (14.1–16.0 grams) shed a mean of 3.8 ± 0.22 ova per set and this figure increased gradually to 5.4 ± 0.28 for the largest females (26.1-28.0 grams). The smallest females (weighing less than 14.1 grams) had larger sets of corpora lutea (4.2 ± 0.24) than those in the next largest weight group, but the difference is of doubtful significance ($t = 1.3$). The youth of these individuals was readily apparent from their gray pelage which, in some specimens, was being replaced by the first brown coat; and in some of these very young females there was more than one set of corpora lutea.

The relationship between number of ova shed and body weight seems not to obtain in *boylei*; the differences between weight classes are not significant and are distributed haphazardly (Table 4). In *boylei* weight may not be such a reliable

indication of relative age; it is a larger species and circumstantial evidence suggests that it is longer-lived than *maniculatus*. Probably many of the *boylei* were trapped after they had attained full size, and the variations in weight may well represent seasonal differences of full-grown individuals. Presumably the sample of *maniculatus* consists almost entirely of growing individuals, relatively few full-grown specimens being included; such being the case, their weight would be a fair indication of relative age. To make the data comparable for the two species, a linear measurement, such as body length, might have been a better criterion for age.

TABLE 3.—*Mean numbers of corpora lutea and embryos per set, according to months with the S. E. of means; specimens examined in parentheses.*

MONTHS	MANICULATUS		BOYLEI	
	CORPORA LUTEA	EMBRYOS	CORPORA LUTEA	EMBRYOS
January	3.1 ± 0.50 (7)		3.6 ± 0.20 (19)	
February	3.8 ± 0.25 (12)		3.7 ± 0.28 (16)	
March	4.1 ± 0.23 (23)	4.0 ± 0.24 (9)	2.9 ± 0.30 (9)	
April	4.7 ± 0.11 (74)	4.4 ± 0.10 (37)	3.5 ± 0.15 (22)	3.1 ± 0.13 (12)
May	4.7 ± 0.11 (52)	4.9 ± 0.16 (20)	3.4 ± 0.16 (19)	3.3 ± 0.26 (12)
June	4.8 ± 0.26 (18)	4.1 ± 0.61 (7)	3.2 ± 0.25 (24)	2.9 ± 0.22 (13)
July	4.0 ± 0.40 (6)	5.7 (3)	2.9 ± 0.36 (11)	
August	4.1 ± 0.25 (12)	4.7 (3)	3.6 ± 0.27 (19)	3.0 + 0.21 (6)
September	4.1 ± 0.25 (19)	4.2 ± 0.43 (5)	3.4 ± 0.25 (16)	3.7 (3)
October	4.7 ± 0.25 (27)	4.6 ± 0.35 (5)	3.3 ± 0.22 (20)	
November	4.4 ± 0.22 (8)	4.4 ± 0.19 (8)	3.3 ± 0.21 (14)	
December	3.8 ± 0.29 (12)		3.0 ± 0.35 (8)	

The size of litters in this study was determined solely by noting the numbers of implanted embryos; these correspond roughly to the number of ova released as judged by numbers of corpora lutea. The litter size for 96 gravid *maniculatus* was 4.6 ± 0.11. Forty-eight gravid females of this species from eastern Washington examined by Scheffer (*op. cit.*) contained a mean of 5.1 ± 0.16 embryos, a figure significantly greater ($t = 2.6$) than that obtained from the northern Sierra Nevada specimens of this study. Howard (*op. cit.*: 19) found that the mean of 25 litters, two days old or younger, was 4.28 for *maniculatus* in southern Michigan. Typically, *boylei* has significantly smaller litters; 42 gravid females carried a mean of

3.1 ± 0.12 embryos. Published references to the litter size of *boylei* are few, and the numbers range from two to four. Long (1940: 178) found four gravid *boylei* in Utah; two held three and two held four embryos.

Larger litters occur at the height of the breeding season in *maniculatus*, but there appears to be no such correlation for *boylei* (Table 3). The mean litter size for *maniculatus* in May is 4.9 ± 0.16, a figure significantly greater than the means for April (4.4 ± 0.10) and March (4.0 ± 0.24). This pattern has been reported

TABLE 4.—*Mean numbers of corpora lutea and embryos per set, according to weight groups, with the S. E. of means; specimens examined in parentheses.*

GRAMS	MANICULATUS		BOYLEI	
	CORPORA LUTEA	EMBRYOS	CORPORA LUTEA	EMBRYOS
12.1–14.0	4.2 ± 0.24 (11)	3.5 (2)		
14.1–16.0	3.8 ± 0.22 (26)	3.8 (4)		
16.1–18.0	4.2 ± 0.17 (44)	4.7 ± 0.17 (14)		
18.1–20.0	4.2 ± 0.13 (66)	4.1 ± 0.16 (29)	3.0 ± 0.54 (6)	
20.1–22.0	4.6 ± 0.13 (56)	4.6 ± 0.16 (23)	3.2 ± 0.20 (18)	2.0 (1)
22.1–24.0	5.0 ± 0.17 (42)	4.9 ± 0.25 (14)	3.4 ± 0.16 (45)	2.9 ± 0.16 (10)
24.1–26.0	5.2 ± 0.21 (11)	4.7 ± 0.50 (6)	3.1 ± 0.13 (41)	3.2 ± 0.18 (5)
26.1–28.0	5.4 ± 0.28 (10)	6.0 (3)	3.4 ± 0.09 (31)	3.2 ± 0.18 (5)
28.1–30.0		5.0 (1)	3.4 ± 0.13 (25)	2.9 ± 0.10 (7)
30.1–32.0			3.5 ± 0.23 (15)	3.8 ± 0.22 (8)
32.1–34.0			4.3 ± 0.53 (10)	3.6 ± 0.10 (5)
34.1–36.0			3.0 (3)	2.7 (3)
36.1–38.0			3.5 (4)	4.0 (2)
All classes	4.4 ± 0.08 (266)	4.6 ± 0.11 (96)	3.3 ± 0.08 (198)	3.1 ± 0.12 (46)

for many small rodents. It seems characteristic of the microtine rodents *Clethrionomys glareolus* (Brambell and Rowlands, 1936: 82), *Microtus agrestis* (Baker and Ransom, 1933), *M. ochrogaster* (Jameson, 1947: 146), and the murid rodent, *Apodemus sylvaticus* (Elton *et al.*, 1931: 674). A different manifestation of the relationship between litter size and breeding activity is seen in the tendency among some microtine rodents for larger litters to be born at the beginning of a cyclical increase: this has been demonstrated for *Microtus pennsylvanicus* by Hamilton (1937: 785) and *M. guentheri* by Bodenheimer (1949: 46).

It is not clear whether larger sets of ova (and larger litters) are caused by changing environmental stimuli or simply reflect the higher proportion of older animals characteristic of spring populations. In wild populations of *Rattus norvegicus*, Perry (1945: 33) found that there was no seasonal variation in the number of ova in a set, or the initial size of litters, when allowance was made for body weight. The presence or absence of ovulation, on the other hand, does not follow the same pattern every year. In the latter half of 1950 there were numerous heavy females of both *maniculatus* and *boylei*; ovulation then was infrequent in *maniculatus* whereas many specimens of *boylei* continued to produce ova.

Because tubal pregnancies are not detected by gross examination, it is impossible to state the loss of ova for all pregnancies. However, discrepancies were noted between the numbers of corpora lutea and implanted embryos in five gravid *maniculatus*. There was a loss of one ovum each in females in which the corpora lutea numbered four (April), five (October), six (September), seven (April), and eight (June). Absorption of all embryos in the set was seen only twice in the 96 gravid *maniculatus* examined; this was noted in a litter of four and a litter of five. In *boylei* two litters, of three each, were noted in which all embryos were being absorbed.

Post-partum pregnancies.—It is well established that some insectivores, rodents, and lagomorphs have a post-partum estrus which frequently results in pregnancy; this topic has been recently discussed by Hamilton (1949). The phenomenon was observed in the present study in 18 *maniculatus* and six *boylei*. Because implantation is delayed by lactation and because preimplantation embryos are not detected by gross examination, many pregnancies in nursing females doubtless went unobserved. It appears that post-partum pregnancies are not exceptional in deer mice, and they may represent the most frequent condition during the height of the breeding season.

The breeding season.—The breeding season is measured in terms of the per centage of fecund specimens, excluding individuals in the gray, juvenile pelage as they are generally not sexually mature. At certain times during this study deer mice became rather scarce, and then the data are sparse. This was especially true in 1951 when their numbers reached a low level. Nevertheless, the small samples readily indicated whether or not reproduction was going on.

Fecundity was inferred from the appearance of the reproductive structures in each sex. For males the criteria for sexual maturity (swollen tubules of the cauda epididymides and enlarged, turgid seminal vesicles and associated lobes of the prostate) can be employed for fecundity. The testes of fecund males are almost always 8.0 mm. or longer for *maniculatus* and 11.0 or more for *boylei*. Females are fecund when they are obviously gravid, lactating, or when the vulva is perforate; any combination of these conditions may be found in the breeding season. The width of the uterine horns changes markedly during the estrus cycle. In the winter, non-breeding period they are slender, about 1.0 mm. or less in diameter at the base, and nonvascularized. During the breeding season the diameter is 1.0 mm. or more, and, when turgid at estrus, they may exceed 2.0 mm. in diameter. Immediately after parturition the horns appear thickened, rugose, and collapsed and may be two or more millimeters in width.

Peromyscus maniculatus commences to breed in late winter (Table 5). In February and March, 1949, a small part of the male population was fecund and the main surge of sexual activity occurred in April. During April and May virtually all males and more than two-thirds of the females were breeding. In 1950 breeding occurred earlier; fecundity was noticed in February, with March and April as the months of greatest activity. In 1951 the onset of breeding more nearly paralleled that of 1949. There was nothing apparent in the weather or food supply to suggest reasons for the differences in beginning of the breeding season. Actually, the food supply and the weather (temperatures and snowfall) were more

TABLE 5.—*Monthly percentages (with S. E. of %) of fecund Peromyscus maniculatus; individuals in the gray, juvenile pelage not included.*

MONTH	SEX	1948	1949	1950	1951
January	M	—	0	0	0
	F	—	0	0	0
February	M	—	8 ± 9	14 ± 2	0
	F	—	0	36 ± 13	0
March	M	—	11 ± 9	92 ± 4	25 ± 9
	F	—	0	79 ± 7	17 ± 9
April	M	—	97 ± 3	98 ± 2	85 ± 7
	F	—	78 ± 9	83 ± 5	70 ± 9
May	M	—	96 ± 3	77 ± 2	80 ± 14
	F	—	69 ± 8	77 ± 2	100
June	M	—	75 ± 6	36 ± 9	50 ± 19
	F	—	43 ± 9	37 ± 13	67 ± 27
July	M	—	—	25 ± 19	91 ± 8
	F	—	—	0	100
August	M	—	32 ± 9	14 ± 7	90 ± 9
	F	—	50 ± 19	4 ± 4	100
September	M	—	25 ± 2	0	—
	F	—	27 ± 2	0	—
October	M	60 ± 20	35 ± 2	0	—
	F	67 ± 19	57 ± 7	0	—
November	M	45 ± 9	10 ± 2	0	—
	F	69 ± 9	17 ± 3	0	—
December	M	9 ± 8	4 ± 1	0	—
	F	17 ± 13	0	0	—

nearly alike in the winters of 1949 and 1950, although, reproductively, the late winter populations of 1949 and 1951 were more similar.

The initial reproductive period of the spring may diminish gradually and cease altogether, as it did in 1950, or there may be a resurgence in the autumn with a termination in December, as occurred in 1949 and apparently in 1948 (Table 5). In years when there is autumn breeding there is a reproductive ebb in mid-summer. Such a lull was noted in *maniculatus* in the Sierra Nevada by Storer, Evans, and Palmer (1944: 176); there were also two peaks in the numbers of young, one in July and August and another in late October and November. In Michigan, Burt (1940: 17) made frequent examinations of individual mice in

wild populations of *Peromyscus leucopus* and found a summer rest period during which many females did not produce. The adult females in Burt's study began again to breed in late summer at about the same time the young of the year were becoming sexually active; the simultaneous breeding in these two age groups created an appreciable autumn increase in reproductive activity. It is interesting that McCabe and Blanchard (1950: 25) observed no mid-summer cessation of breeding for *P. maniculatus*, *P. truei*, and *P. californicus* in the San Francisco Bay region of California; they found the reproductive period was "simple and sustained, with no aestival phase."

TABLE 6.—*Monthly percentages (with S. E. of %) of fecund Peromyscus boylei; individuals in the gray, juvenile pelage not included.*

MONTH	SEX	1948	1949	1950	1951
January	M	—	0	0	0
	F	—	0	0	0
February	M	—	0	0	0
	F	—	0	0	0
March	M	—	0	0	0
	F	—	0	0	0
April	M	—	76 ± 9	100	100
	F	—	32 ± 10	83 ± 11	50 ± 25
May	M	—	100	100	100
	F	—	93 ± 7	100	—
June	M	—	69 ± 11	100	100
	F	—	27 ± 11	93 ± 6	100
July	M	—	—	4 ± 4	100
	F	—	—	24 ± 6	100
August	M	—	75 ± 11	0	100
	F	—	100	0	100
September	M	—	33 ± 11	0	—
	F	—	80 ± 12	0	—
October	M	—	0	0	—
	F	—	7 ± 6	0	—
November	M	0	0	0	—
	F	0	0	0	—
December	M	0	0	0	—
	F	0	0	0	—

The close of the breeding season of *maniculatus* was variable in the Sierra Nevada. In the fall of 1948, breeding was intense (Table 5): in October and November almost half or more of the individuals of both sexes were fecund and even in December there was some reproductive activity. In 1949 a smaller proportion of the population remained fecund in the autumn; but in 1950 there was no sign of reproduction after August, and it was sporadic even in that month. In the latter part of 1948 no males were taken in which the reproductive structures were regressing, but this was seen frequently during November and December, 1949, and as early as August in 1950.

The pattern in *boylei* (Table 6) is somewhat unlike that in *maniculatus*: the

periods of breeding begin later in the spring, cease earlier in the fall, and concern a larger proportion of the population. The first indication of sexual activity in 1949 was observed in April when three-fourths of the males were fecund; previously their reproductive systems showed no hint of activity. In the first half of April, 1949, no females exhibited any manifestations of breeding, yet several gravid individuals were captured before the end of the month. In May almost every individual of both sexes was fecund, but in June there was a rapid decline in breeding activity. The pattern was much the same in 1950 and 1951, but in these years the start of the breeding season was even more sudden.

Breeding had already ceased in November, 1948, when the first specimens of *boylei* were obtained in this study. In 1949 sexual activity extended into September, but in 1950 it terminated before the end of July. The data indicate that breeding may have extended into the autumn in 1951.

The breeding seasons for *maniculatus* and *boylei*, as outlined in the above paragraphs, are probably fairly typical for these species on the western, rather humid slopes of the Sierra Nevada. One exception was noted in a small number of individuals of both species; they represent a population quite different from the other collections, and deserve special mention. They were trapped at Lee Summit, Plumas County, at about 4000 feet in elevation, and about ten miles east of Quincy; this place is well within the coniferous forest. On January 28 and 30 six *maniculatus* and five *boylei* were caught: the *maniculatus* included two very small juveniles (6.0 and 6.5 grams), a fecund male, and a lactating female; a female *boylei* contained two embryos and one male was fecund. The environment suggested no reason for the anomalous behavior except that it approached, in its aspect, the arid region of eastern Washington in which Sheffer (*op. cit.*) found *maniculatus* to breed throughout the year.

The variation between the two species, on the one hand, and the three years, on the other, point at once to fundamental differences and similarities of these two deer mice (Fig. 1). The period of breeding activity is shorter in *boylei*: in no year did this species show signs of sexual awakening until April, although in each of the three years *maniculatus* began the season in February or March. Reproduction begins abruptly in *boylei* and reaches a far greater intensity than in its smaller relative; the period of sexual activity begins gradually in *maniculatus*, and, even at the height of breeding, a few non-fecund individuals are encountered. The close of the breeding season is similarly early and sudden in *boylei*, but has a gradual decline in *maniculatus*. These two species showed similar changes in their breeding seasons from year to year, suggesting that the factors controlling the period over which reproduction occurs are not entirely intrinsic. Both mice seemed to respond similarly to whatever environmental changes may have occurred.

It may be fruitful to consider the importance of food in influencing the breeding span of deer mice. There were great differences in the seed crops from many of the woody plants in both coniferous forests and brushfields in the three autumn periods. The abundance and scarcity of mast paralleled the autumnal periods of sexual activity and quiescence of deer mice. Douglas fir, ponderosa and sugar

pines, oaks, silktassel, and manzanitas bore heavy crops in 1948. In the fall of 1949 the amount of mast produced by these plants was considerably lighter; and in 1950 there were virtually no seeds or berries on any of the above-named plants. When available, mast of this nature may comprise almost all the food of deer mice in fall and winter; but, when such food is lacking, these rodents feed on insects and fungi. This has been discussed previously in some detail (Jameson, 1952). It seems not too speculative to suggest that extension of the breeding season into late summer and autumn or even winter depends largely upon the amount of food produced by plants such as those mentioned. There is a clear correlation between the amounts of mast and reproductive activity for the autumns of 1948, 1949, and 1950; and it is reasonable to believe that food is a basic determinant of the autumn reproduction of these mice.

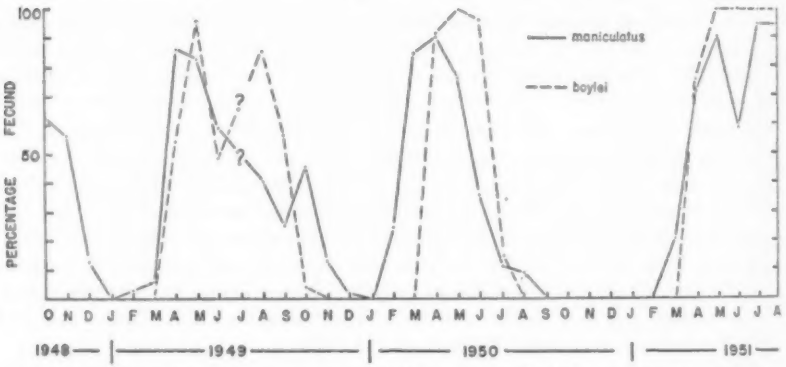


FIG. 1.—Fecundity of *Peromyscus maniculatus* and *P. boylei* from October, 1948, to August, 1951. Percentages represent the combined monthly means of males and females (Tables 5 and 6).

Population changes.—The two species of deer mice in this study represent three environmental groups, inasmuch as *boylei* was found almost exclusively in brushfields and *maniculatus* was sometimes common in both brushfields and coniferous forests (Jameson, 1951). The fluctuations of the mice in these two habitats were not simultaneous.

By noting the numbers of mice taken in traplines, it became apparent that the mice were not always equally abundant. Traplines consisted of 100 traps placed in twenty-five groups of four traps each; the groups were from ten to fifteen yards apart. By dividing the total number of mice taken over a three night period by three, a number is obtained (mice per 100 trap-nights) which affords a means of comparison. In interpreting trap-night data, one should remember that there is a variable and incalculable amount of skewness toward small catches; that is, trapping conditions are never better than perfect and they are generally far inferior. In falling snow, heavy rain, or high wind the catch might be small even in the presence of a large population of mice; but if the mouse pouplation is

small, the catch will be small, regardless of favorable conditions for trapping. The conditions (other than scarcity of mice) that might reduce the catch are so numerous and obscure that it is impossible to consider them in determining mouse abundance: rain seems sometimes to stimulate mouse activity but heavy rain springs many traps; strong moonlight may or may not affect the catch; and there are so many other considerations that it becomes quite impractical to make

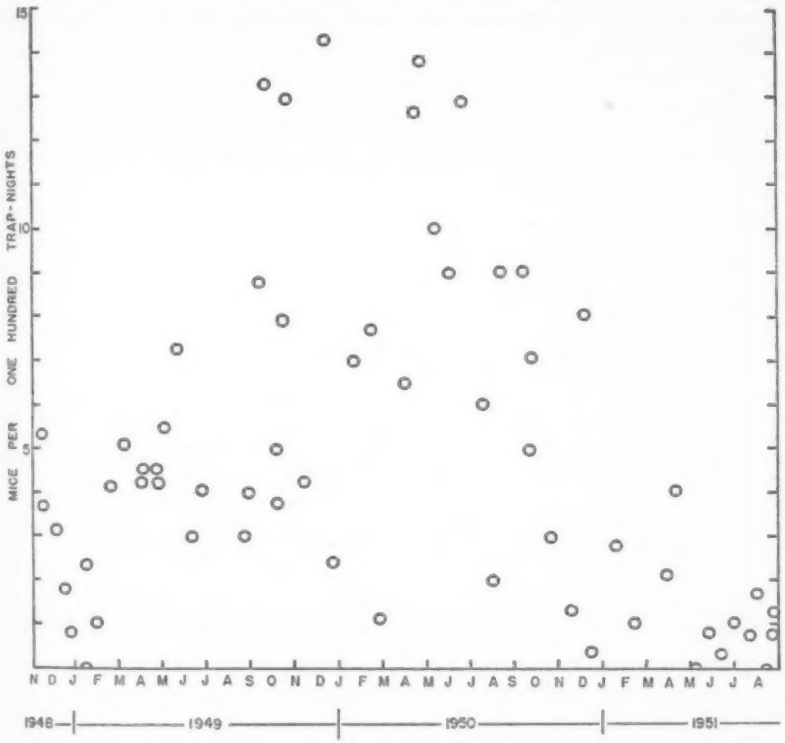


FIG. 2.—Numbers of *Peromyscus maniculatus* per 100 trap-nights from coniferous forests. Circles represent one-third the number of individuals captured in three nights from 100 traps.

corrections for them all. Large catches reflect with certainty a large population, but an actual scarcity is apparent only after repeated and consistent small catches. The information in Figs. 2, 3, and 4 merely indicates a rise and fall in numbers of deer mice over a period of almost three years; it is doubtful that any conclusions beyond this generality are justified.

At the beginning of trapping, late in 1948, *maniculatus* and *boylei* seemed to be about equally abundant in coniferous forests and brushfields, respectively;

maniculatus was then quite scarce in brushfields. In general the fluctuations of *boylei* resembled those of the forest-dwelling *maniculatus*, except that the latter seemed to attain greater abundance (Figs. 2 and 3). Both increased in 1949 and may have been on the upswing when trapping began in 1948. There was a more or less continuous increase until January and February, 1950, for *boylei*, and until late spring, 1950, for *maniculatus*. A subsequent decline in numbers of both *boylei* and the forest-dwelling *maniculatus* is readily apparent. There is a suggestion of a recovery for these populations following the spring breeding in 1951.

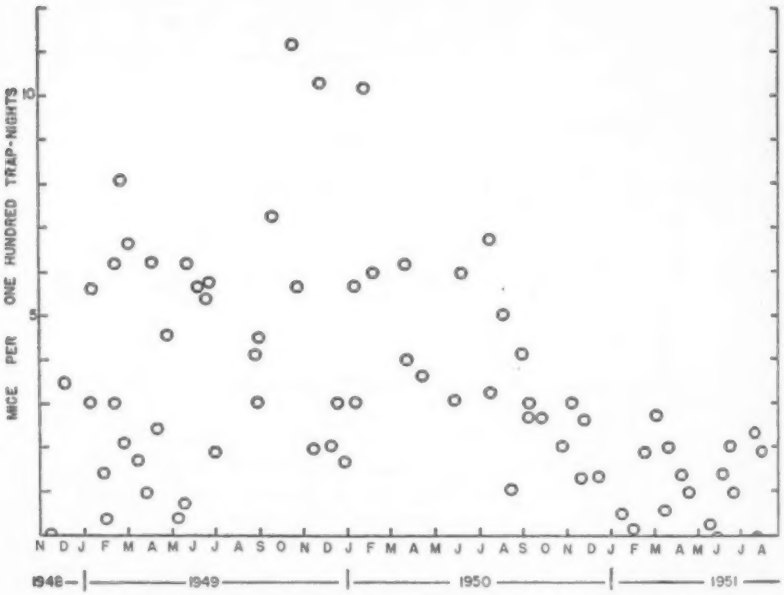


FIG. 3.—Numbers of *Peromyscus boylei* per 100 trap-nights from brushfields.

For the *maniculatus* living in brushfields the rise and fall occurred a year later; these mice reached a maximum late in 1950. From autumn, 1950, until summer, 1951, this population of *maniculatus* seemed to outnumber *boylei*; but by midsummer, 1951, very few *maniculatus* were taken in brushfields. The postponed decline in numbers of *maniculatus* in this habitat suggest a movement of these animals from adjacent forested areas, but this is conjecture.

During the decline there was no suggestion of poor health, disease, or loss of weight; that is, although the individual mice did not appear to suffer, the population did. It seems, therefore, that the changes in numbers of deer mice could be attributed solely to the observed varying rates of reproduction. If the decline was actually the result of a reproductive lull in the late summer and autumn of

1950, it would seem that these rodents must produce some young in the fall months in order to sustain a high population. Such an interpretation may apply only locally or in similar environments.

If the relationship between the amount of mast and autumnal breeding and the subsequent changes in abundance of deer mice should prove to be consistent, this information may be useful to silviculturists in their attempts to seed many once-wooded areas in the western United States. For many years rodents have been indicted as a major cause of failures to reestablish forests by artificial seeding. In some regions deer mice seem to be the rodents of primary importance, but in other places chipmunks and golden-mantled ground squirrels must be considered. It is well known among foresters that many species of coniferous trees reproduce abundantly only at occasional and irregular intervals, the amount of reproduction depending upon the quantity of seed produced and the survival

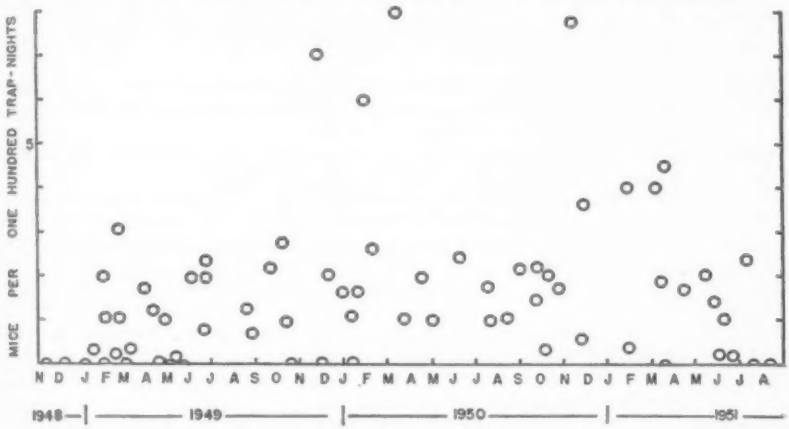


FIG. 4.—Numbers of *Peromyscus maniculatus* per 100 trap-nights from brushfields.

of the seed. Although foresters cannot hope to exert much influence upon survival of naturally sown seeds, a knowledge of rodents fluctuations might assist in planning a program of artificial seeding in burns or heavily-logged areas. If a winter and spring scarcity of rodents could be predicted, the overall success of direct seeding might be increased: in regions where deer mice are the foresters' greatest rodent enemy, it would be well to confine direct seeding operations to years in which deer mice have not bred in the late summer and fall months. This would require a certain amount of research on the part of silviculturists until such time as the absence of autumn reproduction of deer mice is definitely correlated with the failure of mast production.

I am grateful to Milton A. Miller who assisted with the statistical analysis. This study was part of a forest-rodent investigation conducted under the joint auspices of the California Forest and Range Experiment Station and the University of California at Davis.

LITERATURE CITED

BAKER, J. R. AND R. M. RANSOM. 1933. Factors affecting the breeding of the field mouse (*Microtus agrestis*). Part II. Temperature and food. Proc. Royal Soc. London, Ser. B, 112: 39–46.

BODENHEIMER, F. S. 1949. Problems of vole populations in the Middle East. Report on the population dynamics of the Levant vole (*Microtus guentheri* D. et A.). The Research Council of Israel, Jerusalem, 77 p.

BRAMBELL, F. W. R. 1939. Reproduction of the field vole, *Microtus agrestis hirtus* Bellamy. Proc. Zool. Soc. London, Ser. A, 190, Pts. 2 & 3: 133–138.

BRAMBELL, F. W. R. AND I. W. ROWLANDS. 1936. Reproduction of the bank vole (*Evotomys glareolus*, Schreber). I—The oestrous cycle of the female. Philos. Trans. Royal Soc. London, Ser. B, 226: 71–120.

BURT, W. H. 1940. Territorial behavior and populations of some small mammals in southern Michigan. Misc. Publ., Mus. Zool., Univ. Michigan, no. 45, 58 p.

ELTON, C., E. B. FORD, AND J. R. BAKER. 1931. The health and parasites of a wild mouse population. Proc. Zool. Soc. London, 101: 657–721.

HAMILTON, W. J., JR. 1937. The biology of microtine cycles. Jour. Agr. Res., 54: 779–790.

——— 1949. The reproductive rates of some small mammals. Jour. Mamm., 30: 257–260.

HOWARD, W. E. 1949. Dispersal, amount of inbreeding, and longevity in a local population of prairie deermice on the George Reserve, southern Michigan. Contr. Lab. Vert. Biol., Univ. Michigan, no. 43, 50 p.

JAMESON, E. W., JR. 1947. Natural history of the prairie vole (Mammalian genus *Microtus*). Univ. Kansas Publ., Mus. Nat. Hist., 1: 125–151.

——— 1951. Local distribution of white-footed mice, *Peromyscus maniculatus* and *P. boylei*, in the northern Sierra Nevada, California. Jour. Mamm., 32: 197–203.

——— 1952. Food of deer mice, *Peromyscus maniculatus* and *P. boylei*, in the northern Sierra Nevada, California. Jour. Mamm., 33: 50–60.

LONG, W. S. 1940. Notes on the life histories of some Utah mammals. Jour. Mamm., 21: 170–180.

MCCABE, T. T. AND BARBARA D. BLANCHARD. 1950. Three species of Peromyscus. Rood Associates, Publishers, Santa Barbara, 136 p.

PERRY, J. S. 1945. The reproduction of the wild brown rat (*Rattus norvegicus* Erxleben). Proc. Zool. Soc. London, 115: 19–46.

SCHEFFER, T. H. 1924. Notes on the breeding of Peromyscus. Jour. Mamm., 5: 258–260.

STORER, T. I., F. C. EVANS, AND F. G. PALMER. 1944. Some rodent populations in the Sierra Nevada of California. Ecol. Mongr., 14: 165–192.

SVIHLA, A. 1935. Development and growth of the prairie deermouse, Peromyscus maniculatus bairdii. Jour. Mamm., 16: 109–115.

Department of Zoology, University of California, Davis, California. Received January 28, 1952.

AGE VARIATION IN ENAMEL PATTERNS IN THE SPINY POCKET MOUSE, *LIOMYS PICTUS SONORANUS*

By William G. Reeder

Since the study of Recent, and more especially fossil, rodents is based chiefly on the knowledge of the dental structure, it is obviously necessary to obtain as complete data as possible with regard to change of molar cusp patterns during life, as well as through geologic time. Anyone casually examining a large series of nearly any species of mammal can observe that the patterns evident in the newly erupted molar teeth are, to a greater or lesser degree, different from those of adult dentition, as are the heavily worn and often nearly structureless stubs of senile individuals. Ideally, studies in the interspecific comparative morphology of dental structure would be carried out on individuals which are at a similar stage of growth and development. Where large series of Recent mammals are available, this is often possible. The paleontologist, however, is faced with the problem of deducing, often from limited and fragmentary remains, the identity and relationships of various extinct forms. It would appear to be of value, therefore, to treat in detail the variation in dental patterns throughout the life span of each species of mammal.

Between January 25 and February 18, 1947, a large series of spiny pocket mice, *Liomys pictus sonoranus* Merriam, was collected by Mr. Kenneth E. Stager in Mexico, in the vicinity of Copala, Sinaloa. I am grateful to Mr. Stager of the Los Angeles County Museum for the privilege of examining and photographing specimens from this excellent series, which is deposited in that institution. It was observed that the specimens available represented both immature and adult animals, and that there was an almost complete gradation between the pattern of newly erupted teeth and those of very old individuals. The series evidences intergradation of character between the subspecies *sonoranus* and *escuinapae*, but most individuals appear closer to the former.

Two methods of illustrating observed wear have been used. First, photographs of ten individuals of the series showing intermediate wear stages have been reproduced. Thus, from Plate I, the relative rates of wear in the various teeth may be ascertained. Since both upper and lower first molars are the first of the permanent teeth to erupt, they are already functional while the deciduous premolars are still in use. Wear on these teeth thus begins early and is already well advanced when the second and third molars and the permanent premolars emerge. This accounts, at least in part, for the persistence of the original enamel pattern of the second molar to an older stage of the animal's life than it does in the first molar; the pattern of the premolars and third molars are still detectable in older animals, which show little or no enamel elaboration on the first and second molars. Thus, in absence of an entire tooth row, the first molar is identifiable as such if either of the two adjacent teeth are also present.

Figure 1 diagrammatically illustrates the details of pattern change in individual teeth. Each of the represented stages was taken from one of the included photographs, but modifications and clarifications were freely made, in the

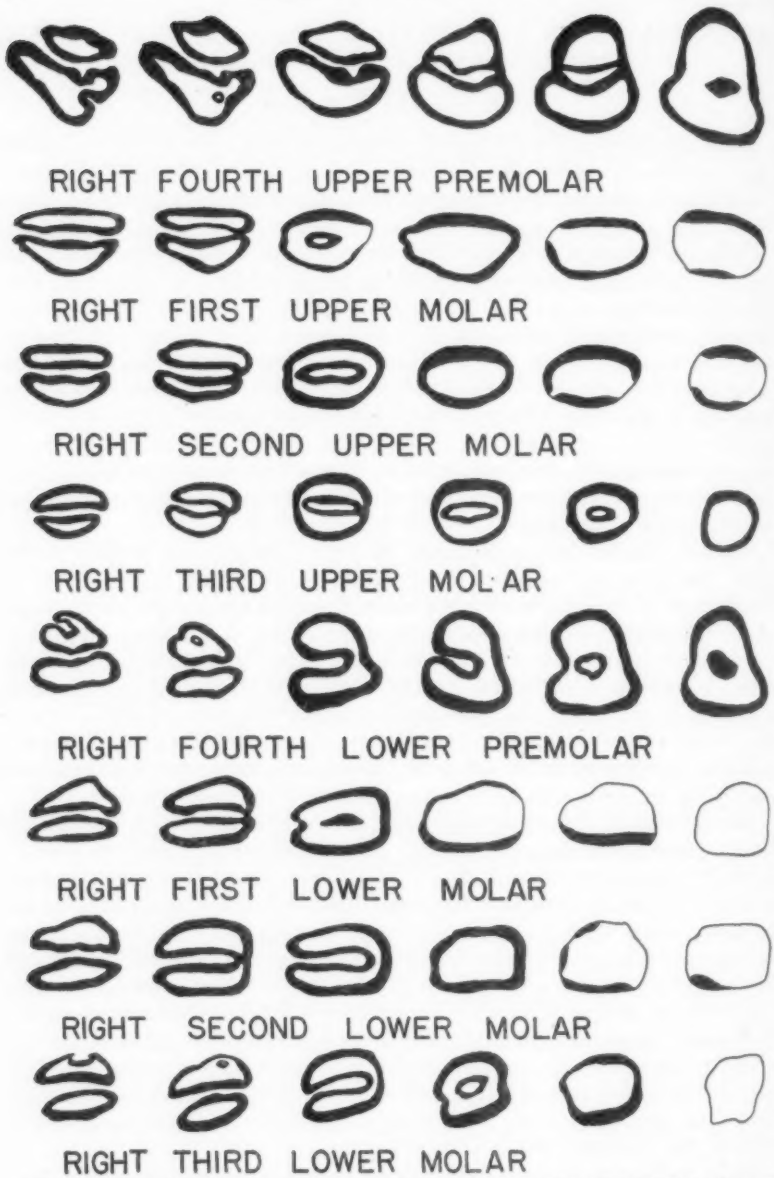

RIGHT FOURTH UPPER PREMOLAR
RIGHT FIRST UPPER MOLAR
RIGHT SECOND UPPER MOLAR
RIGHT THIRD UPPER MOLAR
RIGHT FOURTH LOWER PREMOLAR
RIGHT FIRST LOWER MOLAR
RIGHT SECOND LOWER MOLAR
RIGHT THIRD LOWER MOLAR

FIG. 1.—Molariform teeth of *Liomys pictus sonoranus*, showing variation of enamel pattern with increase in wear of the occlusal surfaces. The wide black areas represent enamel, while the fine lines indicate a boundary of the tooth not capped by enamel.

light of other specimens, so that the dynamic process could be shown in most detail. The patterns represented in the diagram were all but one observed in the right tooth rows of various animals. The youngest stage of the fourth upper premolar, however, was found in a tooth of the left row. In order to make the diagram uniform, and since both right and left teeth presumably develop in an identical manner, the original drawing for a left fourth upper premolar was reversed so as to represent the lacking stage in the right series; it is, therefore, comparable to the other drawings of the group.

The names of cusps and ridges of the teeth, as here used, serve purely as descriptive terms, so as to avoid the implication of homology which is patent in nearly any system of dental nomenclature yet devised. The two lophs present on the teeth are termed the anterior loph or lophid, and the posterior loph or lophid. The median valley separates these two in newly erupted teeth. With greater wear, the remnant of this median valley may be isolated as an enamel island, an enamel ridge surrounding a pit, or as an enamel plateau, in which the enamel forms a central structure without a central pit. The variance of opinion with regard to the problem of homologizing the various portions of the tooth makes it advisable to treat the description of wear in this manner, since it will be usable and will impart the same ideas to all who have occasion to refer to it.

The change of enamel pattern in each tooth will be described briefly in order that the illustrations may be made more clear. Reference should be made throughout the discussion to Plate I, with successive stages in molariform row appearance, and to Figure 1, in which the patterns visible in a single tooth are traced diagrammatically.

Fourth upper premolar.—Since the tooth with least wear in the series happened to fall in the left row, as explained heretofore, there is no photograph of this most elaborate condition, but it is illustrated in the diagram of enamel patterns (Fig. 1). In this early stage, reentrant angles are present both on the postero-lingual and anterior faces of the posterior loph. The anteriormost of these enamel indentations might be termed an incipient angle (Hibbard, Contr. Univ. Mich. Mus. Paleont., 8: 113–192, 1950). The angle in the posterior border of the posterior loph is very rapidly divided off as a briefly persistent enamel island (Plate I, nos. 1, 2, and 4) which leaves no evidence of its presence after slight wear of the tooth surface (no. 3). The anterior incipient angle is inclined in such a manner that with increased wear it becomes less distinct (nos. 5 and 6) and is eventually lost (no. 7). The median valley is deep and persistent, with both buccal and lingual ends similar in depth. It is difficult to determine, with the material at hand, which end of the valley is first closed by fusion of the lophs. It appears (no. 8) that the fusion is first of the buccal extensions of the lophs, then, almost simultaneously, the lingual end, leaving a long enamel island (nos. 8 and 9). With increased wear, this structure becomes an elongate and faint plateau (no. 10) which might in time be lost completely. The angle of projection of this tooth from the jaw is such that with increase in wear there is great expansion of the occlusal area, especially that of the anterior loph, which, in a newly-erupted tooth, has but little area of contact.

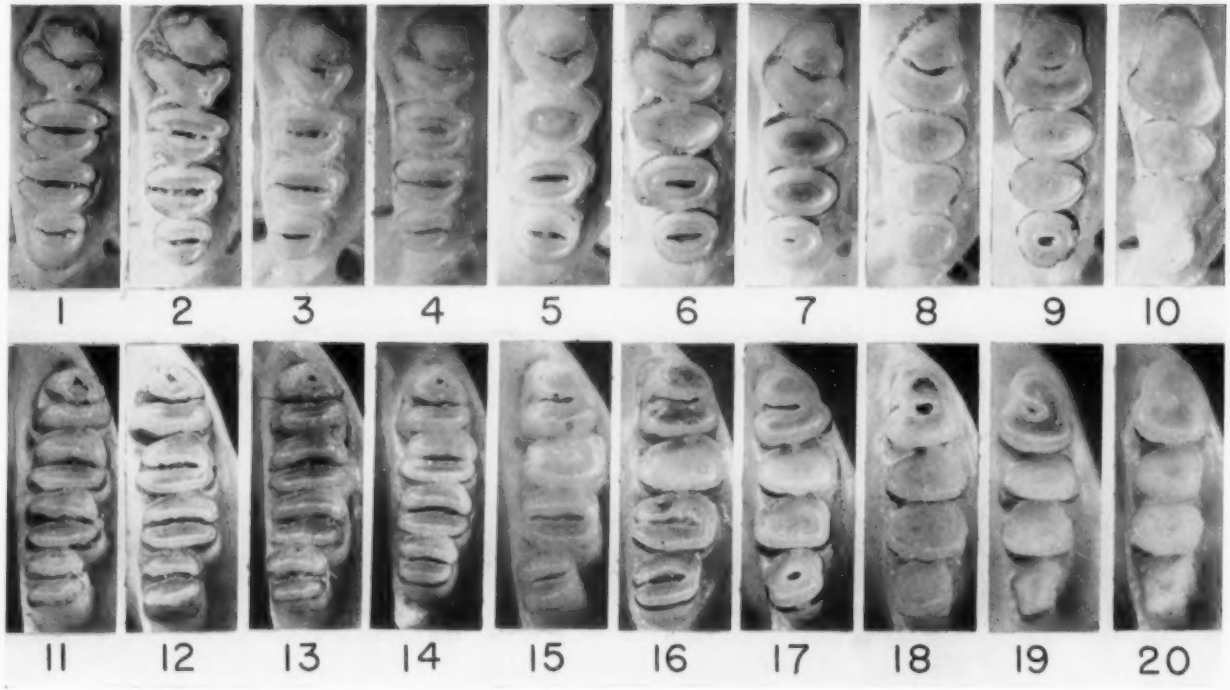


PLATE I

Right molariform tooth rows of *Liomys pictus sonoranus*, illustrating change of enamel pattern with increased wear. Numbers 1 to 10 show least to greatest erosion in upper teeth, while numbers 11 to 20 similarly demonstrate increasing wear in the lower teeth. The specimens illustrated are from the Los Angeles County Museum and are numbered as follows: numbers 1 and 11, LAM 9769; 2 and 12, 9754; 3 and 13, 9771; 4 and 14, 9772; 5 and 15, 9778; 6 and 16, 9763; 7 and 17, 9767; 8 and 18, 9777; 9 and 19, 9762; 10 and 20, 9775.

First and second upper molars.—The patterns of these two teeth vary in similar manner and may be described simultaneously. The two lophs at eruption are distinct and are separated by the median valley. Fusion of the two lophs is first consummated lingually (nos. 3 and 4) then, with increased wear, it takes place buccally (nos. 4 and 5) forming enamel islands, and, at least in the first molar, forms an enamel plateau (no. 5). Further wear rapidly removes all traces of the original median separation of the two lophs. The peripheral enamel bands persist as wide rings (nos. 8 and 9) which in time lose their lateral connections and remain as anterior and posterior enamel plates. The areas of the occlusal surfaces are similar throughout the wearing process.

Third upper molar.—The pattern observed in the series of this tooth is similar to that of the first and second upper molars, and, like them, no reentrant angles are observed. The isolated enamel island formed by the fusion of the two lophs is persistent and is absent in only a small number of individuals with the most greatly worn dentition (nos. 8 and 10).

Fourth lower premolar.—The tooth consists, upon eruption, of two prominent lophids, anterior and posterior, completely separated by a prominent median valley. The antero-internal border of the anterior lophid shows, in the earliest specimens (Pl. I, nos. 11 and 12), a deeply reentrant angle which is very shallow. With gradual abrasion of the surface, this angle is closed by the joining of the enamel of the anterior border of the anterior lophid, and a small enamel island is formed (nos. 13 and 14). To this point the posterior lophid shows little sign of wear, though the peripheral enamel surfaces have become broader. The isolated enamel island of the anterior ridge is similar in depth to that of the buccal end of the median valley so that, with continued wear, both are obliterated at a similar stage (no. 15). The anterior and posterior lophids are at first narrowly, then broadly, joined at the buccal margin of the tooth, since the median valley is deeper lingually and the division of lophids persists at this point. With greater wearing away (nos. 16 and 17) the crown is reduced so that the lingual entrance to the median valley is obliterated, with resultant confluence of the anterior and posterior lophs (nos. 18 and 19). The isolated enamel island thus formed persists, though loosing its median pit, and evolves to a solid isolated enamel plateau in the most heavily worn crowns of the series. The area of the tooth increases somewhat with age, as pointed out by Wood (Ann. Carnegie Mus., 24: 73–262, 1935), although apparently not to the extent described by him.

First and second lower molars.—As in the upper molar rows, the changing patterns exhibited by wear in these two teeth are similar and may be treated together. Both teeth exhibit anterior and posterior lophids, the anterior in each case being somewhat triangular at eruption, with the apex anteriormost. No reentrant angles were observed in any specimens of the series, and none are indicated by persistent enamel plateaus. As in the lower premolars, the median valley was shallower buccally than lingually, and fusion of the anterior and posterior lophids takes place at this tooth margin (nos. 12, 14, 15, and 16). Contrary to the premolar condition, the central and lingual portions of the median valley are quite similar in depth, an enamel island with following plateau is

specimens illustrated are from the Los Angeles County Museum and are numbered as follows: numbers 1 and 11, LAM 9769; 2 and 12, 9754; 3 and 13, 9771; 4 and 14, 9772; 5 and 15, 9778; 6 and 16, 9763; 7 and 17, 9767; 8 and 18, 9777; 9 and 19, 9762; 10 and 20, 9775.

present only briefly after fusion of the lingual extensions of the anterior and posterior lophids (nos. 15 and 16). The shallow nature of the median valley and the thin enamel covering in that region is shown by the rapid loss of any indication of a remnant plateau as wear proceeds (nos. 16 and 17). The peripheral enamel ridges are wider at this stage (nos. 16, 17, and 18) than in the unworn tooth. Later wear rapidly reduces the tooth crown to and past the base of the surrounding enamel band, and it is rapidly lost anteriorly (nos. 17 and 18). While the enamel plate is deeper and more persistent posteriorly, it is broken up (no. 19) and is eventually lost (no. 20). It is probable that the enamel is entirely lost in both first and second lower molars, but the oldest specimen observed had a persistent bit of enamel postero-internally on the second molar.

Third lower molar.—The third lower molar is similarly characterized by an anterior and posterior lophid, separated deeply and completely by a median valley. In unworn dentition, a reentrant angle is found to be located in the center of the anterior face of the anterior lophid (no. 11). This angle is shallow, but before it is reduced and lost by wear it is isolated as an island of enamel with a very shallow pit (nos. 12 and 13). This feature is lost while the lophids are still distinct and their faces unconnected. As in the anterior molars, the lingual portion of the median valley is deeper than the buccal, while the central portion is pit-like and deeper than either. Wear first unites the buccal extensions of the lophids (nos. 15 and 16), then the lingual (no. 17), thus forming an isolated enamel island. Increased wear rapidly eliminates the island and the shallow pit as well as the marginal enamel band (nos. 18, 19, and 20). Since the peripheral enamel does not appear to break up into intervals as in the first and second molars, it would seem that the surrounding enamel plate is of similar depth on all faces of the tooth. The area of the occlusal surface increases to a maximum, then decreases with progressive wear.

The lack of available material has made it inadvisable to attempt to determine year classes or to estimate longevity in this study. The long reproductive season of the subtropical regions might well make it impossible to determine representatives of each year class, since there would be very short or no distinct intervals at which time differential tooth wear might occur between the bearing of litters in various individuals. It must be emphasized that wear as here demonstrated is not alone a function of age, but is also greatly affected by the dominant foods in the precise area in which the individual lived. Animals eating softer vegetation would be expected to show less modification of tooth pattern in a given time than those which, of necessity, eat harsher foods.

Museum of Zoology, University of Michigan, Ann Arbor. Received February 1, 1952.

HIBERNATION IN THE GOLDEN-MANTLED GROUND SQUIRREL, *CITELLUS LATERALIS BERNARDINUS*

By Don P. Mullally

Little is known about hibernation in the golden-mantled ground squirrel, *Citellus lateralis*. Wade (1930) and Grinnell and Dixon (1918) give a few notes concerning hibernation in this species as well as pictures of hibernating individuals. More extensive observations concerning hibernation have been made upon other species of the genus *Citellus* in the United States. Johnson (1928, 1931, 1932) and Wade (1930) present information concerning temperature control in *Citellus tridecemlineatus* and *Citellus franklini*.

The present study of the golden-mantled ground squirrel was undertaken to investigate the species' seasonal activity patterns, body changes accompanying hibernation, body temperature regulation in both the active and torpid states, and to consider the environmental factors responsible for hibernation. A lack of ecological knowledge concerning this species necessitated field studies as well as observations upon captive animals.

Field observations concerning the hibernation and ecology of the golden-mantled ground squirrel were made in the Big Bear Lake and San Gorgonio Peak areas. Data on the species' general distribution was obtained by transects through the mountains.

On October 1, 1950, golden-mantled ground squirrels were captured with padded No. 1 steel-jaw traps and taken to Los Angeles for study. The animals were kept in cages (made of wood and half-inch wire mesh) which measured 3 by 1.5 by 1.5 feet. The cages were furnished with wooden nest boxes measuring 7 by 4 by 5 inches and equipped with removable tops. The cages were kept in a sunny location until some of the animals began to hibernate, at which time the cages were moved into the shade.

Temperatures were taken with a Schultheis quick registering, mercury thermometer especially made for small animal work. The squirrels' temperatures were taken regularly between 8:00 and 10:00 A.M. Ordinarily, in one or two minutes an animal can be picked up from its nest, its body temperature can be taken, and it can be released. Only those body temperatures were recorded that were obtained without previously pursuing the animals. The body temperatures were taken rectally with the thermometer inserted about one-half inch, and orally with the thermometer placed in the back of the mouth.

HABITAT

Citellus lateralis is a widely occurring species in mountain regions of the western United States. It usually is found from the mid-Transition Zone up to timberline. The California subspecies *lateralis*, *perpallidus*, and *bernardinus* occur in the Sierra Nevada, Inyo and White, and San Bernardino mountains, respectively.

Citellus lateralis bernardinus occupies the upper Transition, and the Boreal life zones, occurring in montane and subalpine forest associations only above 6,500 feet. It inhabits both humid and arid situations. In the arid parts of the

Transition Zone, the dominant plants are *Pinus jeffreyi*, *Juniperus occidentalis*, and *Artemesia tridentata*, while in the humid parts of the Transition Zone, the dominant plants are *Pinus jeffreyi*, *Pinus ponderosa*, *Pinus lambertiana*, *Abies concolor*, *Libocedrus decurrens*, *Ceanothus cordullatus*, and *Arctostaphylos patula*. Regardless of their altitudes, even at 8,000 feet, areas dominated by pinon pine and Great Basin sage brush are not occupied by the golden-mantled ground squirrel. Apparently both proper climates and proper plant associations are required by this species.

The specific arid Transition Zone regions that were observed to be occupied by the squirrels lie on the south side of Big Bear Lake east of and including Eagle Point, the south side of Baldwin Lake in areas of yellow pine, north-east of Sugarloaf Peak, and in Holcomb Valley. The most westerly part of the comparatively humid Transition Zone observed to harbor the squirrels was Snow Valley at 6,700 feet elevation. In the Arrowbear, Running Springs, Arrowhead, and Crestline humid Transition Zone areas of lower elevation, the golden-mantled ground squirrel is missing.

The ground squirrels use for food and cover such shrubs as *Ceanothus cordullatus*, *Arctostaphylos patula*, and *Artemesia tridentata*. Other foods are grasses, pine seeds, acorns and insects.

ANNUAL CYCLE OF ACTIVITY

In their natural habitat golden-mantled ground squirrels hibernate throughout the winter. Grinnell and Dixon (1918) report that the Sierra Nevada subspecies was active until the last of October in 1915. Grinnell (1909) reports that a captive animal in Pasadena, California, hibernated within a ground den from October to April, inclusive.

Start of Hibernation.—Throughout the period of study there was no evidence of estivation in either captive or wild squirrels. In their native habitat the ground squirrels were active up to October 27, 1950, but by November 25, none was seen. However, the numbers of active animals diminished from October 1 to October 27 in the Big Bear Lake and San Gorgonio Peak areas. During late October they were basking on rocks and logs in a very fat condition and foraging only close to their dens. In the fall of 1950, climatic conditions were unusually mild with little precipitation, and on November 25 the snow line was at about 9,000 feet. Some individuals remained active longer than others. A similar situation has been reported by Johnson (1928, 1929), Wade (1930), and Linsdale (1946), all of whom found that lean individuals of other species, especially the young and females, remained active the longest.

Seven female and four male squirrels were obtained in the vicinity of San Gorgonio Peak between 7,000 feet and 8,500 feet on September 30 and October 1, 1950. All the squirrels had adipose mesenteries. The males' testes were abdominal and measured 7, 8, 8, and 10 mm. in length. The females had no embryos.

End of Hibernation.—At Big Bear Lake, elevation 6,750 feet, the squirrels had emerged in small numbers in areas clear of snow by March 24, 1951. At this

time most of the squirrels' range was still covered with snow. On April 20, 1950 the species was found active up to 9,000 feet elevation, above which snow was still deep on cool slopes.

By March 9, 1951, only one of the six captive squirrels in Los Angeles showed any tendency to hibernate (Table 2). This animal hibernated occasionally until the first of April and during the day was often inactive within its box even though its body temperature was within the activity range. Some of the others also showed a tendency to remain rather inactive during the first half of March even though body temperatures were as high as those typical of active animals.

During the last week of April, 1950, a total of 19 female and nine male squirrels were obtained from elevations between 6,700 feet and 8,500 feet. Only five of the males had scrotal testes, which were 20 to 25 mm. long. The testes of the non-scrotal males were 7 to 14 mm. long. Certainly, not all males are in reproductive condition the first few weeks after their emergence from hibernation. Seven out of eight females examined still had fair amounts of abdominal fat in their mesenteries, although not so much as in the fall. Most of the males also had some fat in their mesenteries. Thus the squirrels were still quite fat shortly after their emergence from hibernation.

Two of the 19 newly emerged females had embryos. One female had six embryos that were 5 mm. long, four in one horn of the uterus and two in the other. The other female had seven embryos that were 12 mm. long. Copulation must have taken place shortly after emergence from hibernation.

Burrows.—The burrows of the golden-mantled ground squirrels, especially those of the juveniles, are usually short and simple. The squirrels may either dig their own burrows, usually beside some large surface object, inhabit a modified gopher hole, or live in a partially decomposed log or stump. When an animal is pursued, it may go down any available hole. In July and August the young of the year are plentiful and have poorly located and shallow dens. Many of these young seem to be merely moving about and have no special burrow.

The burrows placed under large brush piles were usually short and often were only about 12 inches deep and 18 inches long, while those under logs were as much as 6 feet long, 3 feet deep, and often had several side passages. Fourteen burrows which were excavated had an average depth of 18 inches and an average length of 44 inches. A single entrance is the rule, although several are occasionally present.

The nature of the hibernation burrow is not certainly known because no burrow was excavated which contained hibernating squirrels. However, the occupied burrows which were excavated in April were probably used for hibernation because they had but little freshly dug earth and the animals had been out of hibernation less than a month.

Stored food supplies were rarely found, and actual nests were found only in those burrows that were large and well established and in those with young animals present. It is possible that after hibernation the squirrels block off the passages containing the hibernation nest and food supply, accounting for the

apparent absence of these. Just before hibernation in October, the openings to most of the burrows in the Big Bear Lake region had a large accumulation of *Artemesia tridentata* inflorescences.

BODY TEMPERATURES

Wade (1930) reports that the range of body temperature for normally active *Citellus tridecemlineatus* and *Citellus franklini* is 30–39°C. Johnson (1928) reports a range of body temperature of 32–41°C. in active *Citellus tridecemlineatus*. In the present study normally active *Citellus lateralis* was found to have a body temperature range of 32–40.2°C. At body temperatures of 30–32°C., golden-mantled ground squirrels are inactive within their nests but not in a hibernating condition. Animals within this temperature range seem to be in a transitional stage between the hibernating and normally active conditions. The squirrels are often in this transitional condition during the hibernation months (Table 2) but not at other times. With body temperatures below 30°C., the animals are

TABLE 1.—*Soil temperatures at Eagle Point, Big Bear Lake, California. Elevation 6,750 feet. Arid Transition Zone.*

DATE	DEPTH	TEMP.	REMARKS
Feb. 2, 1951	6–18 in.	.6–2.2°C.	Upper 5″ of soil frozen
Mar. 24, 1951	6–18 in.	4–6.5°C.	Small numbers of squirrels active
Apr. 23, 1950	16 in.	7.8°C.	An excavated burrow
Apr. 23, 1950	24 in.	7.6°C.	An excavated burrow
Apr. 25, 1950	12 in.	6.2°C.	An excavated burrow
May 18, 1951	18 in.	11.8°C.	On sagebrush flats
July 22, 1951	18 in.	17.5°C.	After heavy rains on sagebrush flats
Sept. 2, 1951	18 in.	18.0°C.	On sagebrush flats
Oct. 1, 1951	18 in.	15.0°C.	On sagebrush flats
Oct. 19, 1951	18 in.	11.6°C.	On sagebrush flats, some squirrels hibernating

hibernating and are in the hibernating posture. The lower the body temperature, the greater is the animal's lethargy. The hibernating posture is described by Grinnell and Dixon (1918) and Wade (1930).

There is no sharp dividing line between hibernating and active conditions. Intermediate states exist in locomotor abilities, mental alertness, and use of senses.

The process of awakening from hibernation varies with the squirrel's initial body temperature. When physically disturbed from hibernation with body temperatures lower than 15°C., the animals first straighten their bodies from the previous coiled position and often twitch their feet and distend the hairs on their tails. Within a few minutes the animals begin to shiver sporadically and continue to do so until completely awake. When their body temperatures warm to 14–17°C., their eyes open, and at 17–20°C. the animals are first able to walk, although very awkwardly. When awakened with an initial body temperature above 20°C., the animals are mentally awake at once and are able to run a little.

Awakening from hibernation occurs at a much faster rate with higher initial body temperatures due to a quicker heat production (Fig. 1).

Although their mouth temperatures soon rose to the normal activity range, squirrels awakened from deep hibernation could not run quickly as long as their rectal temperatures remained under about 25°C. The reason for this seemed

TABLE 2.—*Rectal temperatures in centigrade of hibernating ground squirrels. Data recorded in Los Angeles, 1951, from 8–10 A.M. Mercury thermometer used.*

DATE	SQUIRREL NUMBER 1	2	3	4	5	6
Dec. 25	Start of hibernation					
Jan. 18	13.2	14.2	Non-hib.	Non-hib.	Non-hib.	
20	14.5	Non-hib.	"	"	"	
25	36.2	"	"	"	"	
26	30.2	28.2	28.0	"	"	
27	32.6	19.0	33.9	33.6	"	
28	33.0	34.4	34.2	36.2	"	
Feb. 1	26.1	26.6	23.8	30.8	"	
2	31.4	17.2	20.6	Non-hib.	"	
4	9.2	15.5	16.8	30.4	"	
5	22.7	25.2	Non-hib.	Non-hib.	"	
7	15.2	14.9	15.0	"	"	
9	27.6	15.0	15.6	"	"	
10	15.1					
13	18.8	11.0	11.4	Non-hib.	"	13.4
14	32.5	Non-hib.	31.0	"	"	Non-hib.
15	13.8	27.8	Non-hib.	"	"	"
16	12.2	30.5	30.0	"	"	"
18	Non-hib.	26.0	25.5	"	"	"
19	29.1	18.5	27.1	"	"	"
20	16.6	22.5	Non-hib.	"	"	"
21	9.0	34.0	19.2	"	"	"
23	36.0	Non-hib.	11.0	"	"	17.0
25	32.0	13.0	12.9	"	"	Non-hib.
26	Non-hib.	10.2	9.6	"	"	"
27	32.5	13.1	12.4	"	"	"
28	35.6	4.6	4.7	"	"	"
Mar. 4	34.0	16.7	15.0	"	"	"
6	Non-hib.	10–15	10–15	"	"	"
9	"	33.0	31.0	"	"	"
11	35.0	35.2	34.4	"	"	"
15	37.5	Non-hib.	Non-hib.	"	38.0	37.5
28	Non-hib.	"	23.0	"	Non-hib.	Non-hib.
	End of all hibernation					

to be that the colder hind quarters were weak. A slow, awkward gait was characteristic until the posterior region warmed to temperatures near the activity range.

Six captive female squirrels were observed during the winter of 1950–51, and provided hibernation and activity data. Since food and water were available

in excess at all times, a scarcity of these was excluded as a cause for hibernation. At no time did serious fighting take place between the captives.

Whenever a ground squirrel is handled or has its temperature taken, it usually awakens in a short time. The disturbance appears to stimulate the production of body heat. The higher the initial body temperature, the more probable it is that handling will cause an awakening. For these reasons the hibernation of some squirrels in the presence of active ones was a rather surprising phenomenon. At times, with four in a box, two were hibernating and two were not. Although

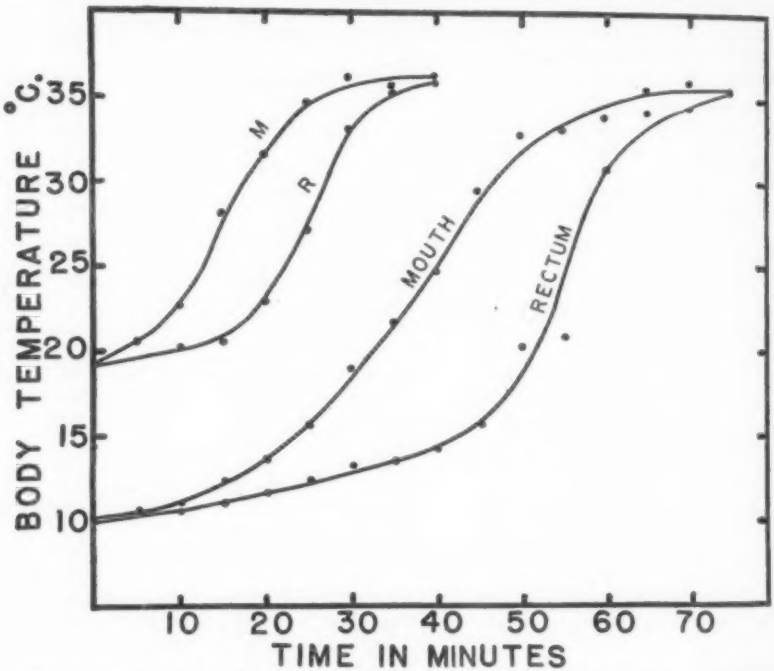


FIG. 1.—The mouth and rectal increase in temperature of two golden-mantled ground squirrels forcibly awakened from hibernation. Data recorded from 9:00 to 10:30 A.M., February 21 and 26, 1951. Air temperatures were 10–15°C.

scuffed by the active ones, the hibernating individuals did not awaken until they were handled. Very commonly, of two nest mates, only one would be hibernating.

The records (Table 2) indicate very sporadic hibernation. Animals may hibernate for several days and then be awake for several more. Individual variations were great, with some animals hibernating most of the time and others not hibernating at all. Any animal awakened remained active the rest of that day. The following day it usually was hibernating again. For these reasons the typical

pattern of hibernation will be distorted if the same squirrels are used for body temperatures every day.

Other workers have found that the rectal rise in temperature lags behind that of the mouth while a ground squirrel (Johnson, 1932) or hamster (Chatfield and Lyman, 1950) is awakening from hibernation. The same relationship was found in the awakening golden-mantled ground squirrel (Fig. 1). Another ground squirrel, awakened at the same time with almost precisely the same body temperature as the animal represented on the left side of figure one, demonstrated a body temperature rise almost identical to that of the graphed example.

Particularly interesting is the comparison of temperature increase in squirrels awakened at body temperatures of both 10°C. and 19°C. The major difference between the two animals seems to be the quicker heat production by the animal with the originally higher body temperature.

Two hibernating squirrels with body temperatures between 12 and 15°C. were placed in a 28°C. room without physical disturbance. When they lifted themselves from their hibernating postures, their mouth and rectal temperatures were taken, and body temperatures were recorded until values were reached characterizing normal activity. One individual awoke one hour and fifteen minutes after being placed in the warm room and then had a rectal temperature of 20.2°C., and an oral temperature of 23.0°C. Upon awakening it proceeded to shiver, and at the time of greatest temperature diversity between head and rectum, the rectum was 26.2 and the mouth 35.8°C. The other individual awoke one hour and forty minutes after being placed in the warm room when it had a rectal temperature of 21.0°C. and a mouth temperature of 22.5°C. At the time of greatest temperature difference, the rectum was 26 and the mouth 35°C. A possible reason for the second animal's delayed awakening was its greater size with a correspondingly slower body temperature rise by heat absorption from the warm room. The long time required to awaken the squirrels in the warm room makes it unlikely that a skin stimulus of warm air was the cause of awakening.

Other workers have found that most of the body heat in hibernating mammals is contributed by the immediate environment. The present investigation upon the golden-mantled ground squirrel also indicates this to be so. Rectal temperatures were usually lower than mouth temperatures, indicating some heat production at all times in the anterior part of the animal. Usually the difference was a matter of a few tenths of a degree, but in the two lowest body temperature records, rectal temperatures 4.6 and 4.7°C., the difference amounted to 0.8 and 0.7°C. respectively, indicating a rise in heat production with a very low drop in body temperature. Study of the hibernation records reveals that squirrels in the same nest in deep hibernation usually have approximately the same body temperatures. This is further evidence of lack of individual difference in heat production under similar conditions.

DISCUSSION

The golden-mantled ground squirrel hibernates almost as long in Los Angeles as it does in its native habitat. This equivalent period of hibernation in two

areas climatically very dissimilar suggests that the severity of climate is not the usual immediate cause for hibernation. Seasonal changes in the two areas coincide, however, indicating that direction of environmental change may be as important or more important than the absolute values of environmental factors in stimulating the start and end of hibernation.

At Big Bear Lake, environmental temperatures are not the same at entrance and emergence from hibernation. In the fall, hibernation commences even in the absence of snow and with ground temperatures about 8–15°C. Air temperatures average 5–8°C. at this time (U. S. Weather Bureau, Climatological Data, 1948). Hibernation ceases during March and early April when ground temperatures at den depth are 4–7°C., and air temperatures average 2–4°C. Scattered snow is still present usually, and plant growth has not yet started. Environmental conditions are far from favorable. The above evidence indicates that environmental temperature influences hibernation only in a general way.

Normally, cool weather does not seem to stimulate hibernation. If snow is absent, the squirrels are equally active at different elevations under different temperature conditions, and in the fall they retire for hibernation at about the same time at all altitudes. The animals come out in the sunlight early in the morning even though air temperatures are below freezing. In the spring the animals at lower elevations are active while the ones in areas of snow cover are still hibernating, or at least inactive. Snow forces them to remain in their dens, but whether or not they are hibernating at all times beneath the snow is unknown.

Excessively warm temperatures seem to be influential in preventing hibernation. Squirrels in Los Angeles generally began hibernating later than those at Big Bear Lake. During the hibernation months, the animals in Los Angeles were more active during periods of warm weather. The captive squirrels were often observed to hibernate during the night but to be active during part of the day.

The factors initiating and ending hibernation are obscure. One line of evidence may be very important: none of the captive squirrels continuously hibernated throughout the hibernation period. Occasionally each of them awoke for one or several days. If this same behavior prevails in nature, the disappearance of snow in the spring, usually during March, might be readily discovered by some awakening squirrels and emergence would result. Reduction of body fat and rising environmental temperatures would tend to promote emergence.

SUMMARY

Citellus lateralis bernardinus is a common ground squirrel of the San Bernardino Mountains in the upper Transition, Canadian, and Hudsonian life zones. Two requisite environmental factors are elevations above 6,500 feet and montane or subalpine forest.

In their native habitat the squirrels hibernate from October or November to the middle of March or early April. Many captive squirrels hibernated in Los Angeles from December 25 to early March in 1951. However, not all captive squirrels hibernated in Los Angeles, and those that did hibernated intermittently.

At the start of hibernation, ground temperatures at den depth are 10–15°C.

During the winter the soil temperature in a typical den drops to at least 2°C. At the time of emergence from hibernation, the soil temperatures at the den level range from 4–7°C.

Hibernation occurs in this species any time body temperatures drop below 30°C. Animals with body temperatures of 30–32°C. are in a transitional condition between the hibernating and awake conditions. Normally active squirrels have body temperatures of 32–40°C.

In both hibernating and active squirrels, the oral temperature is usually somewhat higher than that of the rectum. In squirrels forcibly awakened from hibernation, the oral temperature exceeds the rectal by many degrees while body heat is being produced.

Two squirrels awakened from hibernation in a warm room (28°C.) when their mouth temperatures were 23.0 and 22.5°C. and their rectal temperatures were 20.2 and 21.0°C., respectively.

Acknowledgements.—For their aid, I would like to thank Drs. Raymond B. Cowles and George A. Bartholomew, Professor and Assistant Professor of Zoology, respectively, at the University of California, Los Angeles. I would also like to thank my mother, Mrs. Bryan J. Mullally, for her time and effort in typing the manuscript.

LITERATURE CITED

Chatfield, P. O., and C. P. Lyman. 1950. Circulatory changes during the process of arousal in the hibernating hamster. Amer. Jour. Phys., 1630: 566–574.

Grinnell, J., and J. Dixon. 1918. The ground squirrels of California. Monthly Bul. State Com. Hort., 7 (11-12): 597–708.

Grinnell, J. 1908. The biota of the San Bernardino Mountains. Univ. Calif. Publ. Zool., 5.

Johnson, G. E. 1928. Hibernation in *Citellus*. Jour. Exper. Zool., 50: 15–30.

——— 1931. Review of hibernation in mammals. Quart. Rev. Biol., 6: 439–461.

——— 1931. Hibernation of the thirteen-lined ground squirrel. Am. Nat., 63: 171–180.

——— 1932. Hibernation of the thirteen-lined ground squirrel. Biol. Bul. Marine Biol. Lab., 57 (2): 107–129.

Linsdale, J. 1946. The California ground squirrel. Univ. Calif. Press., Berkeley.

Shaw, W. T. 1925. The hibernation of the Columbian ground squirrel. Can. Field. Nat., 39: 56–82.

——— 1925. Observations on the hibernation of ground squirrels. Jour. Agr. Res., 31: 761–769.

——— 1926. A short season and its effects upon the preparation for reproduction by the Columbian ground squirrel. Ecology, 7: 136–139.

Wade, O. 1930. Behavior of certain spermophiles with special reference to hibernation and estivation. Jour. Mamm., 2: 160–188.

Department of Zoology, University of California, Los Angeles. *Received February 9, 1952.*

INTERGRADATION BETWEEN *MARTES AMERICANA* AND *MARTES CAURINA* IN WESTERN MONTANA

By Philip L. Wright

Since 1890 when Merriam described *Martes caurina* from the coast of Washington, the marten of western continental North America have been considered to belong to two species, *Martes americana* and *M. caurina*. In his revision of the group Rhoads (1902) substantiated Merriam's contention that *M. caurina* was specifically distinct from *M. americana*. In addition he described another subspecies of *caurina* from Colorado which he named *origenes*. He was puzzled by the occurrence of a race of *caurina* in the southern Rockies since *Martes americana abietinoides* had been described earlier from the Selkirk Range in British Columbia (Gray, 1865) and he suspected that the latter or some other race of *americana* occurred in the adjacent southern Rockies and wondered if there was not some geographical barrier which separated the two species. Rhoads apparently saw no specimens from Montana or Idaho. Davis (1939) partially cleared up the problem when he found that *Martes caurina caurina* occurred in central and southern Idaho and thus showed that a portion of the area from which Rhoads saw no material was occupied by the coastal form and thus the known ranges of the two subspecies of *caurina* were brought much closer together. Davis did not see material suggestive of conspecificity between the two species. Dalquest (1948) stated that he had examined many marten skulls from various areas in the west, that he saw no evidence that there is intergradation between the two species and that they should stand until such evidence is forthcoming.

That the solution to the problem of the relationship between the two species could be found from study of the marten of Montana was first brought to my attention in 1941 when marten skulls from the Whitefish and Sapphire ranges in western Montana were sent for identification to Drs. E. R. Hall and W. W. Dalquest, then at the University of California. They compared these skulls with specimens in the Museum of Vertebrate Zoology and reported to me that those from the Whitefish Range were very close to skulls of *abietinoides* from southeastern British Columbia and those from the Sapphire Range were typical of *caurina*. The trapping of marten in western Montana was prohibited for several years so that it was not possible to obtain additional material until 1946 when trapping was again permitted. In 1946 and again in 1950 special effort was made to obtain as many skulls as possible from trappers. With the excellent cooperation of numerous Fish and Game Department employees, 152 specimens were obtained. Many of the specimens were skinned carcasses preserved in formalin by the trappers in the field. Almost all of these skulls are in the collection of the Montana State University Zoological Museum (MSUZM). Additional specimens from central and northern Idaho, from southeastern British Columbia, and southwestern Alberta were borrowed from the U. S. National Museum (USNM), the Museum of Vertebrate Zoology of the University of California (MVZ), the National Museum of Canada (NMC), and from Montana State College (MSC).

Skulls from Barkerville and Suswap, B. C. (USNM) (Fig. 1), since they came from areas close to the type locality of *abietinoides*, were used as representative of that form. The Whitefish Range, Flathead and Lincoln counties, Montana, which lies directly west of Glacier National Park, furnished the largest series of specimens. This region is Montana's best marten habitat. The specimens from northern Idaho (USNM) came from Coolin and northeast of Coeur D'Alene.

FIG. 1.—Map showing general localities of regions from which the specimens were collected. 1, Barkerville, B. C.; 2, Suswap, B. C.; 3, Whitefish Range; 4, northern Idaho; 5, Swan River, South Fork of the Flathead River, and Sun River Region; 6, Clearwater Region of Idaho; 7, Sapphire Range; and 8, Red Lodge Region.

This series included those skulls obtained by Rust from trappers and referred to by him (Rust, 1946). These specimens were regarded by H. H. T. Jackson as *M. c. caurina*. The specimens from the Swan River, South Fork of the Flathead River, and Sun River regions, Missoula, Powell, and Lewis and Clark counties, came from an area of continuous marten habitat extending from the east slope of the Mission Range on the west to the east slope of the continental

divide some 50 miles to the east (MSUZM and MSC). Specimens from the Clearwater region came from another extensive area of continuous marten habitat; from the Clearwater River, the Lochsa River, White Sand Creek, and Packer's Meadow in Clearwater and Idaho counties (MVZ, USNM, and MSUZM). The Sapphire Range specimens (MSUZM and USNM) came from the crest of the Sapphire Range east of Stevensville, Hamilton, and the east Fork of the Bitterroot, Ravalli County. The Red Lodge region specimens (MSUZM) came from West Rosebud and Horse Shoe creeks, Stillwater County, and from Red Lodge Creek, Carbon County. In all 245 skulls were examined.

Marten skins, because of their value, are not common in museums. The small number of skins in the U. S. National Museum from Idaho and Montana were examined and a series of 12 skins and skulls from Banff and Jasper national parks from the National Museum of Canada was examined. Seven specimens were collected by me during the course of the study: three from Glacier National Park, two from the Whitefish Range, one from the Swan Region, and one from the Sapphire Range. Several hundred skins, mostly from the Whitefish Range but including nearly 100 skins from Ravalli County and about 30 from the South Fork of the Flathead, have been examined in the possession of trappers and fur buyers. Most of the skins from Flathead County were owned by Glenn Johnston, fur buyer of Kalispell, who has been very cooperative in allowing access to his material.

In order to study the variation in the cranial characters used by the earlier workers to distinguish the two forms *Martes americana abietinoides* and *Martes caurina caurina*, cranial measurements, many of them taken in accordance with the system of Grinnell, Dixon, and Linsdale (1937), were obtained with a vernier caliper calibrated to one-tenth of a millimeter. Thirteen measurements were taken of each skull that was intact. For each area within both sexes the means, standard deviations, and standard errors were calculated and the results are summarized in Table 1.

In general, the measurements present a rather uniform picture with little significant variation between the skulls of various areas. Some measurements apparently vary with the age of the animal. Since many of the Montana specimens were skinned carcasses, reproductive tracts were available for study. The ovaries of all females were serially sectioned, stained, and examined for the presence of corpora lutea. The presence of corpora lutea in winter-taken marten indicates that the animal is pregnant and carrying unimplanted embryos in its uterus (Wright, 1942; Marshall and Enders, 1942). The assumption has been made in this case that those female marten without corpora lutea are immature and thus younger in age than those with corpora. The bacula from many of the males were also recovered, cleaned, and weighed. Apparently the baculum of the marten may be used (Marshall, 1951) as in the long-tailed weasel (Wright, 1947) and other carnivores (Petrides, 1950) to indicate which males are mature. Following the system of Marshall, which appears satisfactory in this regard, the males with bacula weighing less than 100 mg. were considered to be immature and those with bacula over 100 mg. were considered to be adults. A series of

specimens from the Whitefish Range, from which complete data were available on the reproductive tracts, included 31 adult males, 10 immature males, 24 adult females, and 14 immature females. Using this series, the two age classes were compared for all the cranial measurements. The means of the following measurements differed at the 5 per cent level in either one or both sexes: greatest length of skull, condylobasal length, postorbital constriction, postorbital processes, and zygomatic breadth. The other characters, some of which may vary with the locality, are of interest taxonomically, and do not appear to vary with age.

The characters that clearly vary with the locality and are to be discussed here are the length of the auditory bulla, the length of the inner lobe of the upper molar, the rostral breadth, and the height of the cranium (Plate I). The auditory bulla was measured from the paraoccipital process to the anterio-medial corner of the bulla. In general, this is a measurement which can be taken repeatedly with an error of not more than one-tenth of a millimeter. It also indicates as well as any easily taken single measurement the general size of the bulla. The length of the inner moiety of the upper molar, the rostral breadth, and the height of the cranium can also be taken in a precise way.

These characters are some of those used by Merriam (1890) to distinguish *caurina* from *americana* in his original description of the former species. His specimens of *americana*, however, were from the Adirondacks of New York rather than from British Columbia. Merriam made considerable use of ratios between measurements, but I have dealt with the measurements directly since it is possible to distinguish the forms in question without resort to ratios. Rhoads (1902) discusses the length of the inner moiety of the upper molar, the general size of the auditory bulla, and the cranial height in distinguishing the *caurina* group from the *americana* group. Neither worker had many specimens available for study and their discussions often center about the differences between single specimens from different areas.

In this study the method of Dice and Leraas (1936) has been used to portray the variation in the first of the above mentioned three characters (Fig. 2). The mean is shown as the perpendicular line at the center of each figure, the extreme limits of the sample are shown as the ends of the fine lines, the standard deviation as the heavy line, and the boxes are two times the standard error on each side of the mean. In general, if the positions of the boxes do not overlap, the populations in question will show a t value in excess of the 5 per cent limit. That is, there will be a significant difference between the populations.

Examination of Table 1 and Figure 2 indicates that there is a progressive decrease in the length of the auditory bulla and the cranial height, and an increase in the length of the inner moiety of the upper molar and the width of the rostrum in specimens from northern to southern areas. These appear to be good examples of clines as described by Huxley (1939), Mayr (1947) and other workers. Variation of this type is often encountered when specimens are collected from a series of stations within the range of a single species.

If we regard the two British Columbia series as representative of *abietinoides* and the series from the Sapphire Range as *caurina*, the Whitefish Range series

TABLE 1.—*Summary of cranial measurements. The first figure given is the mean, the second is the standard deviation* $\left(SD = \sqrt{\frac{\Sigma d^2}{N-1}}\right)$, *and the third the standard error* $\left(SE = \pm \frac{SD}{\sqrt{N}}\right)$.

FEMALES LOCALITY	NO.	GREATEST LENGTH OF SKULL	CONDYLOBASAL LENGTH	BASILAR LENGTH	PALATILAR LENGTH	ZYGOMATIC BREADTH	MASTOID BREADTH	POST-ORBITAL CONSTRICTION	POST-ORBITAL PROCESSES	INTER-ORBITAL BREADTH	WIDTH OF ROSTRUM	HEIGHT OF CRANIUM AT BULLAE	AUDITORY BULLA	INNER MOIETY OF UPPER MOLAR
Barkerville, B. C.	5	74.04	72.10	65.93	34.88	39.63	32.14	16.24	19.48	16.20	13.30	28.06	18.60	3.94
		.957	.841	.586	.371	1.087	.883	.851	.971	.682	.235	.667	.353	.158
		.428	.420	.293	.166	.544	.395	.381	.434	.305	.105	.298	.158	.071
Suswap, B. C.	19	72.07	70.27	64.53	33.98	38.91	31.35	16.13	19.26	15.82	13.42	28.41	17.78	3.90
		1.507	1.488	1.352	1.137	1.470	.723	.927	.970	.604	.552	.784	.662	.182
		.346	.384	.328	.261	.337	.166	.213	.223	.139	.127	.180	.152	.041
Whitefish Range, Mont.	34	73.74	72.03	66.08	34.54	40.18	32.03	15.96	19.79	16.11	13.43	27.84	18.13	4.01
		1.656	1.584	1.599	.949	1.349	.755	.976	.999	.639	.413	.917	.646	.337
		.294	.279	.282	.163	.251	.129	.169	.174	.111	.071	.160	.112	.058
Northern Idaho	9	71.53	67.20	64.04	33.40	39.64	31.28	15.20	19.79	16.31	13.72	27.22	17.47	4.03
		1.784	3.428	2.041	1.117	.977	1.244	.986	1.170	.949	.492	.765	.730	.267
		.595	1.143	.680	.372	.326	.415	.329	.414	.336	.164	.255	.243	.089
S.F., Swan, Sun Rivers, Mont.	17	73.95	72.09	66.31	34.94	40.68	32.73	16.04	20.43	16.81	14.05	27.65	17.50	4.47
		1.512	1.581	1.536	1.188	1.415	.840	1.162	1.174	.600	.454	1.227	.978	.408
		.391	.408	.396	.285	.354	.210	.300	.294	.150	.110	.307	.245	.099
Clearwater Region, Idaho	6	72.95	70.62	64.63	33.82	41.12	32.82	15.27	20.35	16.32	13.93	26.64	16.08	4.77
		.852	.791	.894	1.152	1.143	1.101	1.413	.527	.535	.179	.604	.662	.214
		.342	.323	.365	.470	.511	.492	.577	.215	.218	.073	.270	.270	.087
Sapphire Range, Mont.	10	73.98	71.84	65.86	34.02	40.84	33.25	16.27	20.15	16.58	14.32	26.97	16.14	4.94
		.943	2.996	1.268	1.125	1.318	.700	1.312	.679	.447	.494	.780	.691	.309
		.314	.999	.423	.356	.417	.221	.415	.215	.141	.156	.260	.219	.098
Red Lodge Region, Mont.	7	73.55	71.20	65.52	34.61	41.02	33.91	16.40	21.30	17.14	14.90	27.46	16.16	4.96
		2.426	2.961	2.795	1.507	1.577	.490	1.016	.802	.687	.678	.749	.280	.251
		.994	1.328	1.253	.575	.617	.201	.385	.304	.260	.256	.308	.107	.095

MALES LOCALITY	NO.	GREATEST LENGTH OF SKULL	CONDYLOBASAL LENGTH	BASILAR LENGTH	PALATILAR LENGTH	ZYGOMATIC BREADTH	MASTOID BREADTH	POST-ORBITAL CONSTRICTION	POST-ORBITAL PROCESSES	INTER-ORBITAL BREADTH	WIDTH OF ROSTRUM	HEIGHT OF CRANIUM AT BULLAE	AUDITORY BULLA	INNER MOIETY OF UPPER MOLAR
Barkerville, B. C.	9	81.02	79.07	72.97	38.64	44.63	34.83	16.71	21.76	18.01	15.50	30.26	19.35	4.48
		2.636	2.563	2.372	1.661	2.861	1.051	.846	1.037	.586	.335	.826	.895	.212
		.879	.854	.791	.554	1.012	.350	.282	.346	.195	.112	.275	.299	.071
Suswap, B. C.	13	79.81	77.86	71.66	38.25	43.52	34.34	16.57	20.89	17.42	14.80	30.02	19.07	4.43
		1.908	1.717	1.668	.605	2.480	.687	.675	.772	.721	.552	.652	.576	.280
		.529	.572	.528	.168	.687	.191	.212	.214	.200	.153	.181	.160	.078
Whitefish Range, Mont.	40	81.48	79.14	73.04	38.76	45.14	34.96	16.24	21.86	17.96	15.22	30.20	19.13	4.75
		2.186	2.143	1.906	1.236	2.522	1.075	1.148	1.599	.823	.573	.781	.683	.341
		.346	.352	.305	.186	.404	.172	.181	.253	.130	.091	.123	.107	.053
Northern Idaho	10	78.69	76.21	70.52	37.23	43.33	34.46	16.46	21.30	17.56	14.87	29.95	18.41	4.64
		2.252	2.384	2.525	1.201	2.152	.868	.942	1.281	.490	.539	.520	.632	.176
		.712	.754	.802	.538	.681	.275	.298	.405	.155	.110	.164	.200	.055
S.F. Swan, Sun Rivers, Mont.	15	81.24	79.40	73.23	38.87	46.51	36.49	16.22	22.45	18.74	16.21	29.50	18.17	5.47
		1.992	1.516	1.711	.834	2.717	1.033	.830	1.851	1.075	.547	.529	.764	.340
		.514	.391	.442	.215	.726	.267	.214	.477	.276	.141	.137	.197	.088
Clearwater Region, Idaho	13	80.23	77.61	71.34	38.39	45.74	36.03	16.25	22.35	18.10	15.77	29.45	17.12	5.51
		1.668	2.145	2.145	.939	1.800	1.078	.923	1.055	.711	.627	.711	.465	.210
		.482	.619	.619	.260	.636	311	.256	.293	.197	.174	.205	.134	.058
Sapphire Range, Mont.	11	80.21	77.71	71.24	37.89	45.81	36.25	15.64	22.02	18.00	15.85	29.18	16.93	5.75
		1.387	1.366	1.416	.947	2.152	.764	1.337	1.201	.680	.650	.691	.431	.347
		.418	.412	.427	.285	.681	.230	.403	.362	.205	.196	.208	.130	.105
Red Lodge Region, Mont.	5	81.18	79.44	72.86	39.06	47.08	37.08	16.28	23.35	19.40	17.02	30.30	17.02	5.86
		1.488	1.690	1.368	.805	2.389	1.145	1.042	.930	.605	.512	.688	.512	.255
		.660	.758	.614	.360	1.076	.511	.465	.465	.302	.230	.308	.230	.114

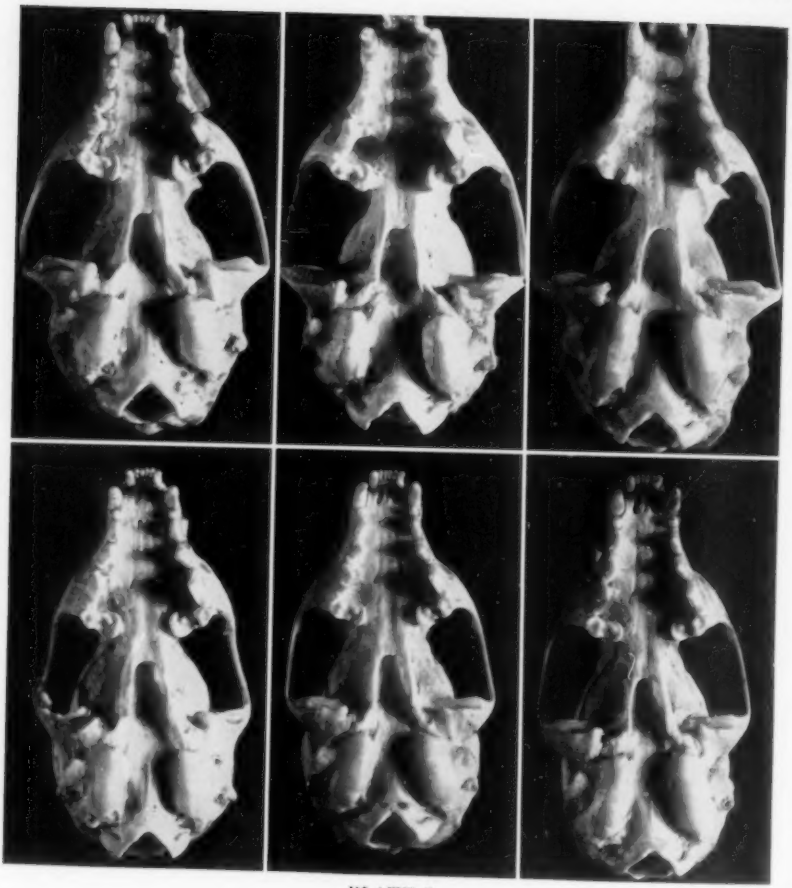


PLATE I

Ventral view of auditory bulla and inner lobe of upper molar of representative skulls of Montana martens. All approximately four-fifths natural size. All specimens are in the Montana State University Zoological Museum. These particular skulls were selected because their measurements were close to the means of their respective sample for the characters shown.

From left to right, above.

Martes americana caurina, ad ♂, 117, Sapphire Range, Ravalli County. Intergrade between *abietinoides* and *caurina*, ad ♂, 268, Swan River Region, Missoula County. *Martes americana abietinoides*, ad ♂, 253, Whitefish Range, Lincoln County.

From left to right, below.

Martes americana caurina, im. ♀, 118, Sapphire Range, Ravalli County. Intergrade between *abietinoides* and *caurina*, ad. ♀, 285, South Fork of Flathead, Missoula County. *Martes americana abietinoides*, ad ♀, 3573, Whitefish Range, Flathead County.

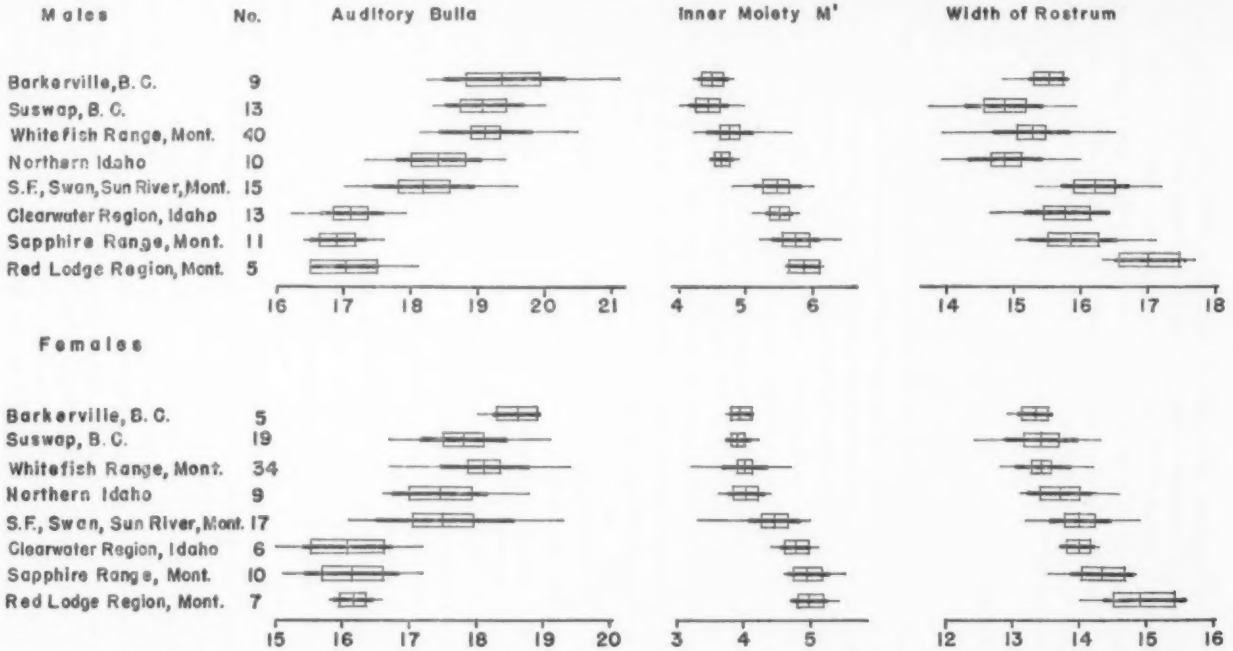


FIG. 2.—Graph of measurements of the length of the auditory bulla, the length of the inner moiety of the upper molar, and the rostral breadth. See text for explanation.

is very similar to those from British Columbia. The animals from northern Idaho are clearly of the *abietinoides* type but show some tendency toward *caurina*. The Clearwater and Red Lodge Region series are close to that from the Sapphires. The Swan, South Fork, Sun rivers series is intermediate between these two types. The means of the auditory bulla in this series are nearer to the means of the samples regarded here as *abietinoides*, but the rostral breadth, the inner moiety of M^1, and the cranial heights are intermediate, or more like those of *caurina*.

Marten skins, from some areas at least, are highly variable with respect to color, so that it is often necessary to examine large series in order to describe the limits of variation to be expected in any one area. Although several hundred skins have been seen from Montana, it has not been possible to assemble the different series. Whenever a series has been examined, the general coloration of the dorsal and ventral fur has been compared with the plates in Ridgway (1912). The colors indicated below for the dorsal and ventral fur were taken midway between the front and hind legs, about half way between the mid-dorsal or mid-ventral lines and the side of the skin as seen in cased skins. In general, the key appears to work satisfactorily, but occasionally colors are found on the skins that can not be matched closely with those in Ridgway. The skins of Montana marten examined were similar in several respects. The heads were nearly all grizzled and generally lighter colored than the dorsum. The lighter color of the head did not extend behind the ears, the dorsal color of the neck was like that of the back. Almost all of the skins showed a well-marked mid-dorsal line of darker fur. In all but a very few of the darkest skins, the feet and tail were darker than the rest of the body. The light colored patch between the eyes and ears which Rhoads described from a single specimen of *abietinoides* and regarded as typical of the races of *americana*, was not seen in any Montana specimen. The inner margins of the ears were grayish, but in no examples could they be classed as white. The colors range from Drab to Pale Ecru–Drab.

The series of nearly 300 skins from the Whitefish Range exhibited great variability with respect to color. A very few skins were classed by Mr. Johnston, the fur buyer, as "steel" and were as light as Isabella Color or Mouse Gray both dorsally and ventrally. A large series comprising about one-third of the total, regarded as "light", were Buckthorn Brown dorsally and Dresden Brown ventrally. Over half of the skins were classed as "medium" and were Cinnamon Brown to Dresden Brown dorsally, and Antique Brown, Brussels Brown, Sudan Brown, or Mummy Brown ventrally. In this medium group the venter was often more orange than the dorsum and in both this and the "light" group the ventral coloration was darker than that of the dorsum. The remainder of the skins comprising about 15 per cent of the total were classed as "dark". These ranged from Mummy Brown dorsally and ventrally to almost black. In some of the darkest skins the top of the head was almost as dark as the rest of the body. Some of the skins showed a sprinkling of long silver hairs scattered over the body.

The size and color of the throat patch were highly variable. The patch ranged from five or six inches square to almost complete absence. It was usually

interrupted. The darker skins tended to have smaller throat patches than the light ones. The color of the patches ranged from Pale Orange-Yellow to Capucine Yellow or Deep Chrome. The skins were almost all provided with long dense under fur which stood erect with only a slight shake of the skin. The under fur was dark; in two "dark" and three "medium" skins it was Hair Brown. In the dark skins, especially, when the hair was separated the effect was one of only slight contrast between the tips and the bases of the hair. The appearance of the hairs was one of bicolor. This bicolor effect was noted by Gray in his original description of *abietinoides*. Later it was discussed by Rhoads and stated to be a unique character of this form, which should produce the highest quality of fur from the standpoint of the furrier. The appearance of these furs from the Whitefish Range is pleasing because of the fairly dark colors, the dense under fur, and the lack of contrast between the outer and under fur. They bring good prices to the trapper. The three specimens taken in Glacier National Park during the course of this study show no differences from the Whitefish Range material.

Most of the 12 skins from Banff and Jasper parks are Cinnamon-Brown dorsally like many in the medium group from the Whitefish Range, but one, being lighter, is Ochraceous-Tawny. Another is almost black and thus similar to very dark skins from the Whitefish Range. This series differs only slightly from those of Whitefish Range; there is a little less orange in the ventral region and the throat patches are paler. In quality the two series are identical, both having very dense, long, under fur. Since in these two populations dark skins are outnumbered by lighter colored examples, it is felt that Gray and Rhoads (who substantiated Gray in regarding the marten of southeastern British Columbia as typically a very dark colored animal) did not see enough animals to know that their descriptions appear to apply to only a minority of the individuals.

About 80 skins were examined from the Sapphire Range and from the Bitterroot Range to the west. These specimens were much more uniform in color and were inferior in quality to those from the Whitefish Range. Almost all of the colors on these skins were to be found in Plate III of Ridgway, whereas the dorsal coloration, at least, of the Whitefish Range specimens were largely in Plate XV. The dorsal fur of most was near Sudan Brown, a few were as dark as Brussels Brown or Prout's Brown, others were Antique Brown or Amber Brown and a few were decidedly orange, being near Mars Yellow. The ventral fur was Sudan Brown or Amber Brown.

The throat patch was large, often not interrupted, and in some the lighter color of the throat patch extended continuously on the mid ventral region to the anus. This character was not seen on any animals from the Whitefish Range. The color of the throat patch ranged from Capucine Yellow to Cadmium Orange, with most being Orange. The skins as a group had shorter hair generally, and conspicuously less under-fur. Some skins (for example, MSUZM 1295) were of poor quality and "ratty" by contrast with good skins from the Whitefish Range. Due to lighter, more orange pelts and to the less dense fur, these skins bring lower prices to the trapper. Average skins from these two areas could be distinguished at once by one familiar with both types.

A series of about 30 skins from the Spotted Bear Region (50 miles north on the South Fork River from the source of the skulls used in this study) were conspicuously more orange than skins from the Whitefish Range. The lightest were Mars-Yellow dorsally and Raw Sienna ventrally; the darkest were Brussels Brown or Raw Umber dorsally. This series exhibited less dense under-fur than those from farther north. The throat patches range in size from very large to almost none, and, in color, from Deep Chrome to Cadmium Yellow. Two specimens from the Sun River (MSC) have very dense, long fur but are colored like Sapphire Range animals. One specimen from the Swan Region (MSUZM 1296) is identical as regards color and density of pelage with the light group from the Whitefish Range.

No skins have been seen from northern Idaho but skins from the Yaak Region of extreme northwestern Montana were not dissimilar to those from the Whitefish Range. Three skins from Running Creek, Clearwater Region, Idaho, (USNM) are not different from skins from the Sapphire Range. No prime winter skins have been seen from the Red Lodge Region although four summer and early fall skins from this region (USNM) appear to differ little from the type of *caurina*.

DISCUSSION

In view of the fact that the skulls from the Whitefish Range and from northern Idaho are essentially similar to those from Suswap and Barkerville, B. C., with respect to the size of the auditory bulla and other cranial characters, and that skins from the Whitefish Range exhibit the very dense under fur previously described as characteristic *abietinoides* from the Selkirk Range, these populations are classed as *M. a. abietinoides*. The series from the Sapphire Range and the Clearwater Region, since they agree in regard to cranial characters with the published description of *caurina* from Washington (Merriam, 1890) and since the skins from these areas are very similar to the type specimen of this form, are classed as *caurina*. The specimens from the Swan, South Fork, and Sun rivers Region are intermediate between these types as regards both cranial and pelage characters. Since intergradation is occurring between populations previously regarded as distinct species, it appears that we are dealing with only a single species. Accordingly, *Martes caurina* is reduced to subspecific rank. Since the area of intergradation is very extensive, it would be very difficult to draw a line for separation of the subspecies. Accordingly, it appears best to regard the population of the Swan, South Fork, Sun rivers Region as one of intergradation. There is, today, no barrier between the ranges of *abietinoides* in the Whitefish Range and Glacier National Park regions and the intergrading populations in the Swan, South Fork, and Sun rivers Region and the Sapphire Range populations of *caurina* still farther south.

As a result of the relegation of *M. caurina* to subspecific rank the scientific names of the members of the *caurina* group are changed as follows:

Martes americana caurina (Merriam)
Martes americana origenes (Rhoads)

Martes americana nesophila (Osgood)
Martes americana sierrae Grinnell and Storer
Martes americana humboldtensis Grinnell and Dixon
Martes americana vancouverensis Grinnell and Dixon

The material from the Red Lodge Region, at present represented by only a small series of skulls, is clearly of the *caurina* type. However, there is some suggestion that these animals may have broader skulls since several of the transverse measurements average larger than in the Sapphire Range series. The possibility remains that this population may eventually be found by further investigation to belong to the subspecies *origenes* or perhaps to some undescribed subspecies, but for the present they are referred to *caurina*. The type specimens of *origenes* in the National Museum do not appear to me to differ markedly from the type of *caurina*. Surely there are much greater differences in color between selected specimens from the Whitefish Range than there are between the types of *caurina* and *origenes*. Since both subspecies were described from small series, it seems desirable that the status of *origenes* should be reinvestigated.

SUMMARY

Skulls and skins of marten from various regions in northwestern Montana and central and northern Idaho have been studied. Statistical analysis of cranial characters has been undertaken and variation in the pelage described. *Martes americana abietinoides* and *Martes caurina caurina* intergrade in the Swan, South Fork of the Flathead, and Sun rivers Region of western Montana. Accordingly the latter form and the other races of *caurina* are classified as subspecies of *americana*.

LITERATURE CITED

Dalquest, W. W. 1948. Mammals of Washington. Univ. Kan. Publ., Mus. Nat. Hist., 2: 1-444.

Davis, W. B. 1939. The recent mammals of Idaho. The Caxton Printers, Ltd., Caldwell, Idaho.

Dice, L. R. and H. J. Leraas. 1936. A graphic method for comparing several sets of measurements. Contr. Lab. Vert. Biol. Univ. Mich., 3: 1-3.

Gray, J. E. 1865. Revision of the genera and species of Mustelidae contained in the British Museum. Proc. Zool. Soc. Lond.: 100-154.

Grinnell, J., J. S. Dixon, and J. M. Linsdale. 1937. Fur-bearing mammals of California. Univ. Calif. Press, Berkeley, California.

Huxley, J. S. 1939. Clines: an auxiliary method in taxonomy. Bijdr. Dierk., 27: 491-520. (Quoted by Mayr.)

Marshall, W. H. 1951. An age determination method for the pine marten. Jour. Wildlife Mgt., 15: 276-283.

Marshall, W. H. and R. K. Enders. 1942. The blastocyst of the marten (Martes). Anat. Rec., 84: 307-310.

Mayr, E. 1942. Systematics and the origin of species. Columbia Univ. Press, New York.

Merriam, C. H. 1890. Descriptions of twenty-six new species of North American Mammals. North Amer. Fauna, 4: 1-55.

Petrides, G. A. 1950. The determination of sex and age ratios in fur animals. Amer. Midl. Nat., 43: 355-382.

RHOADS, S. N. 1902. Synopsis of the American martens. Proc. Acad. Nat. Sci. Phila., 54: 443–460.

RIDGWAY, R. 1912. Color standards and color nomenclature. (Washington, D. C., published by the author.)

RUST, H. J. 1946. Mammals of northern Idaho. Jour. Mamm., 27: 308–327.

WRIGHT, P. L. 1942. Delayed implantation in the long-tailed weasel (*Mustela frenata*), the short-tailed weasel (*Mustela cicognani*), and the marten (*Martes americana*). Anat. Rec., 83: 341–353.

———. 1947. The sexual cycle of the long-tailed weasel (*Mustela frenata*). Jour. Mamm., 28: 343–352.

Department of Zoology and Montana Cooperative Wildlife Unit, Montana State University, Missoula, Montana. *Received February 25, 1952.*

MIGRATION OF THE NORTHERN FUR SEAL, *CALLORHINUS URSINUS*

BY KARL W. KENYON AND FORD WILKE

The purpose of this paper is to summarize the voluminous and scattered published information on the migration of the northern fur seal and to present unpublished data accumulated in the past ten years. Emphasis is placed on the seals which breed on the Pribilof Islands of Alaska, since very little information is available concerning the seals born on Robben Island (near Sakhalin) or the Commander Islands (east of Kamchatka). The only other breeding colonies of the northern fur seals, those on Mushir, Srednoi, and Raikoke Islands of the Kuril chain, were wiped out during a period of intensive pelagic sealing, 1871–1911. Rumors that small colonies are reestablished on one or more of these islands are unverified. Unfortunately, it is impossible to distinguish, on anatomical grounds, the animals which originate on the various breeding islands (Wilke, 1951).

Between 1871 and 1911 pelagic sealing was carried on extensively in the waters of the North Pacific and the Bering Sea. Since sealing vessels operated in offshore areas where the most seals were available, the pelagic sealing records contribute the best data available as to where fur seals concentrate during their migratory movements. Dr. C. H. Townsend (in Jordan, 1899, vol. 3) ably summarized the pelagic sealing records then available. Since Townsend's work no extensive studies of the distribution of seals were undertaken until 1940 when the Fish and Wildlife Service assigned the M.S. *Black Douglas* to pelagic seal investigations. After the interruption caused by the war, the *Black Douglas* made several cruises to the Pribilof Islands, one cruise in 1947 out the Aleutian chain to Attu, and another in 1948 across the North Pacific from Unalaska to southern California, then northward parallel to the coast as far as Cape Flattery, Washington. In addition, the U. S. Coast Guard has been very cooperative in reporting observations of seals at sea.

Seals marked with metal tags on the Pribilof Islands and later recovered elsewhere have furnished data as to the location of seals of specific age classes at certain times.

Under the joint auspices of the Natural Resources Section, General Headquarters, Supreme Commander for the Allied Powers and the U. S. Fish and Wildlife Service, Wilke spent over a year in 1949–50 studying the distribution of seals along the Japanese coast.

Limits of range of the northern fur seal.—The fur seal from the Pribilofs regularly migrates southward in winter to the coastal waters off central California as far as Latitude 34° North, and off Japan to about Latitude 36° North. A few wander south of these latitudes. The most southerly specimen record is a female taken at San Diego, California (Huey, 1942). Although comparatively few seals are recorded from the central North Pacific, pelagic sealers took young seals in June and July as far south as Latitude 40° in mid-Pacific areas. During the summer and fall the seals evidently range widely in the Bering Sea. They have been observed in some numbers north of the Pribilofs; the farthest north record was a large bull which was photographed on Sledge Island, near Nome (Bernard, 1925).

A belief commonly held until recently was that the seals from the Pribilof breeding grounds and those from the Commanders and other westerly islands followed separate routes in migration. Those from the Pribilof breeding herd were assumed to migrate through the waters of the western North Pacific Ocean while those breeding on Robben and the Commander Islands were the winter migrants along the western side of the North Pacific (Jordan, 1898). We now know that some of the seals originating on the Pribilof Islands migrate to the Asiatic side of the Pacific. Whether Asiatic seals cross over to the American coast is unknown, but it is a distinct possibility.

General distribution of seals on migration.—In general, the northern fur seal is an animal of the open sea during its five to eight months away from the breeding islands. After leaving the Aleutian passes the majority of adult females and subadults of both sexes fan out in a southward movement across the North Pacific. Most of them reach the coastal waters of North America from southern California to Sitka during the winter months. Here they accumulate from ten to fifty miles offshore, and in early spring move northward in a loose aggregation paralleling the coast. In late May and June they move westward through the Gulf of Alaska and along the Alaska Peninsula toward the Aleutians and the Bering Sea.

On the Japanese coast they first appear off Hokkaido from the North in October, increasing to a peak of abundance in late December, then declining as they go farther south. Their early arrival on the Honshu coast in January is followed by an increase and concentration that reaches its climax in late April and May. The northward movement lags behind that on the American coast. Many seals linger off northern Honshu in late May or even early June, and they are still about Hokkaido in June.

During their winter migration seals segregate themselves, to a variable degree, according to sex and age classes. Of 148 seals taken in the early spring of 1950 and 1951 by Tlingit sealers (accompanied by the writers) on the protected waters of West Crawfish Inlet near Sitka (Plate II), all were adult females four years old or older. Their ages were determined by tooth-ridge counts (Scheffer, 1950*b*).

The seals were taken without selection by the sealers so that the uniformity of this sample should reflect the actual composition of this group of seals.

While gathering specimens off the Japanese coast Wilke (1951) found that seals in certain areas were either predominantly males or females, and that certain age classes, animals less than one year of age and males over five years of age, were conspicuously absent. The relative absence at sea of males over five years old does not appear strange, since a great number of three- and four-year-olds have been taken during commercial sealing operations. However, animals less than one year of age should be the most numerous age class and we can only assume that these young animals are widely scattered elsewhere on the open sea.

Numerous observations leave little doubt that adult females and the young of both sexes range widely at sea. However, the writers are unable to state with certainty where the majority of adult males winter. They have recorded only six adult males away from the Pribilof Islands—four off Japan, one off central Oregon, and one in Unimak Pass. Observations by pelagic sealers and early students of the fur seal indicate that the adult males remain for the most part in northern waters. These observers state that the bulls leave the Bering Sea mainly because of adverse weather conditions and then venture only short distances south of the Aleutian chain or into the Gulf of Alaska. Few apparently follow the other age classes in their extensive wanderings at sea.

MONTHLY SUMMARY OF KNOWN OCCURRENCES OF THE NORTHERN FUR SEAL AT SEA

(See Townsend's chart of pelagic sealing records, Jordan, 1899, vol. 3, for a general and graphic demonstration of the monthly distribution of seals.)

January.—Widely dispersed at sea, being recorded as scattered across the North Pacific from Unalaska in the Aleutians (Hooper, MS, 1892) to Puget Sound, southward along the coast of the United States to the Mexican border (Huey, 1942), the greatest numbers being found from Sitka, Alaska (letter, U. S. Coast Guard, 1948) southward. A few are recorded between southern Hokkaido and northern Honshu.

February.—Widely scattered; observed near the Islands of the Four Mountains, in the central Aleutian area (letter, U. S. Coast Guard, 1941) and off the coasts of central California (Brooks, 1937; Hanna, 1951), Oregon (Jewett, 1921, 1925, 1933), Washington (Scheffer, 1939), and at Sitka in southeastern Alaska (letter, D. D. Swanson, 1942). On February 3, 1950 the writers flew in a PBY airplane (courtesy of the U. S. Coast Guard) on a 1,000 mile flight covering the coastal waters off Washington and Oregon to the California border. They saw 85 seals, mostly off Washington near the 100 fathom contour. Pelagic sealing records indicate only that the bulk of the herd is scattered loosely along the northern California, Oregon, and Washington coasts. The number of seals on the Honshu coast off Japan increases in February, particularly off Fukashima Prefecture.

March–April.—Scattered along the west coast from central California to the head of the Gulf of Alaska and west to Akutan Pass. Sealing records indicate that in March the seals are concentrated off Washington and Vancouver Island, B. C. (Clemens, Hart, and Wilby), 1936) and southeastern Alaska; in April they move somewhat northward into the Gulf of Alaska. On the Japanese coast the animals are scattered from Fukashima to Iwate Prefectures in March. In April a marked increase occurs off Miyagi Prefecture.

May.—Scattered from northern California (Scheffer, MS, 1941) through the Gulf of Alaska to the Shumagin Bank, off the southwestern portion of the Alaska Peninsula (letter,

U. S. Coast Guard, 1941). Few have penetrated into the Bering Sea (Scheffer, MS, 1944). Sealing records indicate that the bulk of the herd is in the Gulf of Alaska. In April and May seals are concentrated in an offshore band reaching from 20 miles south of Kinkasan, Japan, to 30 miles north of Miyako. Scattered seals are to be found northward off Aomori Prefecture and Hokkaido.

June.—Seals are recorded both north and south of the Pribilofs. Hanna (1920) found them north of the islands in 1916 along the margin of pack ice up to within eight miles of St. Matthew Island. They are recorded from mid-Pacific (Tanner, 1883) and southeastward to the waters off the Washington coast. Some seals are still present near northern Honshu but they are most numerous off Hokkaido. Apparently the main body of seals off Honshu passes far offshore from Hokkaido.

July.—Most of the herd is concentrated in the Bering Sea about the Pribilofs. However, young, non-breeding animals recorded off Vancouver Island, B. C. (Clemens and Wilby, 1933) and scattered at sea in the central North Pacific. The last seals leave Hokkaido waters except for occasional young animals.

August.—A few seals were taken south of the Alaska Peninsula and Aleutian chain during pelagic sealing days. A dead seal was found on the beach of Whatcom County, Washington (Scheffer, MS, 1945). On August 24, 1951 several seals were observed in Akutan Pass. Relatively few, and these mostly young, non-breeders, are recorded south of the Bering Sea. Young seals have been seen off Iwate Prefecture, Japan.

September.—Although the writers have been at sea enroute to the Pribilof Islands from Seattle during September, they have seen seals only in the Bering Sea. However, young seals a year or two old are widely scattered. One was taken off Queen Charlotte Sound in a gill net (Scheffer, MS, 1949). Old sealing records indicate that a few were found south of the Aleutian chain at this season. One record is far north in the Bering Sea on Sledge Island, near Nome (Bernard, 1925).

October.—The bulk of the seal herd is still present in the Bering Sea. Many young seals are just arriving on the Pribilofs while others, especially adult females, have started their southward migration and are recorded in the North Pacific at 150° West Longitude, 50° North Latitude (letter, Commander Midtlyng, U. S. Coast Guard Weather Ship, 1948). The first animals appear off Hokkaido.

November.—Seals leave the Pribilofs in large numbers. They were recorded headed southward through the eastern Aleutian passes, but westward the writers found them extremely scarce. In 1947 on a cruise along the Aleutian chain from Unalaska to Attu and back, eleven seals were observed—most of these shortly after leaving Unalaska. They are scattered across the Northeast Pacific enroute to the west coast of North America. They increase in numbers in the southern Hokkaido area during November.

December.—Some seals, numbering several thousand, are still present in the vicinity of the breeding islands, but the majority have left. The writers found them scattered across the North Pacific between Unalaska and San Francisco, the greatest number being seen a few miles west of the Farallon Islands. In general, they have accumulated in the coastal waters of central California, Oregon (Jewett, 1930), and Washington (Scheffer, MS, 1941), and are arriving in small numbers at Sitka in southeastern Alaska (letter, Klingbeil, 1950). They are most abundant about southern Hokkaido in December.

OBSERVATIONS

Proximity to land during migration.—The fur seal is essentially an animal of the open sea while away from the breeding islands, but exceptions of this general rule are of regular occurrence. A few thousand adult females habitually enter some of the deep outer straits and inlets of southeastern Alaska during the winter and spring herring runs (Plate II). They have also been reported by aboriginal sealers within the entrance of the Strait of Juan de Fuca (Scheffer, MS, 1938). Jewett (1925) reports the capture of an immature seal in Tillamook Bay, northern Oregon. Two were shot from shore in the mouth of the Copalis

River by mistake in 1948 by a hair seal hunter; a male was caught in a net 300 yards within the mouth of the Quillayute River, Washington, by an Indian fisherman (Jackson, letter, 1947); and another was shot about 60 or 70 miles from salt water on a tributary of the Ugashik River of Alaska in November of 1949 (Stan Chmiel, affidavit, 1950).

Reports from natives of Unalaska that fur seals had been known to come ashore on Samalga Island (a small island off the west end of Umnak Island, in the Aleutians) in years past prompted the *Black Douglas* party to visit the island on June 6, 1947. They found about 120 fur seals which appeared to be males of various ages, hauled out on a rocky reef at one end of the island (Scheffer, MS, 1947). However, the majority of reports of fur seals found on

PLATE I

LEFT: Adult female fur seal. The white whiskers of this animal identify it as an adult, its size and the shape of its head, as a female. When overtaken by ships at sea the animals rise up to satisfy their curiosity as shown here. Photo. by Karl W. Kenyon.

RIGHT: The flippers of a sleeping or resting fur seal are often held above the water's surface. West Crawfish Inlet, near Sitka, Alaska, January, 1951. Photo. by Ford Wilke.

the beaches of California, Oregon, and Washington are of dead or sick animals which have drifted in or come ashore because of weakness (Hall, 1940).

Factors affecting the distribution of seals.—**Water temperature.** Apparently water temperature plays an important part in determining the pelagic distribution of seals. Their occurrence at sea indicates that they prefer surface water temperatures between 47 and 52°F. In late November seals were seen moving rapidly southward through Unimak Pass where the water temperature was 40.6°F. They were encountered infrequently southward on a 2,000 mile cruise between Unalaska and San Francisco. The water temperature rose approximately 1°F. in each 200 miles, from 40.6 to 57.0°F. Seals were most numerous off

northern California and southern Oregon where the water temperature was 50.1°F. Off northern Japan in early March seals were found in 43 to 45°F. water and were taken during April and May the following year in water with a surface temperature ranging from 41 to 54°F. They occurred in greatest abundance in water between 47 to 54°F. (Wilke, 1951). The preference of fur seals for water of a given temperature may be only apparent, in that it may really be a response to abundant food, such as schools of lantern fish or squids.

Food. Seals are usually scattered over wide areas well offshore from coastal fishing banks. The seals collected off Japan were in water ranging from 600 to 9,000 feet in depth. They feed largely at night on pelagic forms (Hanna, 1951), mainly lantern fish and squids (Schultz and Rafn, 1936; Wilke, 1951) which are then near the surface. The greatest depth at which a fur seal has been taken in a net is 240 feet (Scheffer, 1946). At sea there is no consistent correlation between fur seal distribution and the location of commercial fisheries. Apparently areas of upwelling, well off shore, are attractive to seals (Hanna, 1951). Too little is known about populations of non-commercial forms, such as lantern fish, to attempt to correlate their distribution with that of fur seals. On the other hand, the few thousand adult females which enter the protected inlets in the Sitka area gather there to feed on the schools of herring which come to spawn. All of the 148 female seals taken there in 1950 and 1951 had fed on herring (Wilke and Kenyon, 1952).

PLATE II

A concentration of fur seals in West Crawfish Inlet near Sitka, Alaska, in January 1951. Although fur seals are predominantly animals of the open sea during migration, several thousand adult females regularly enter inlets along the northwest coast to feed on spawning herring. Photo. by Ford Wilke.

Weather. It is obvious during summer and fall storms on the Pribilofs that seals are disturbed by wind-driven rain. The animals leave exposed areas and haul out where the terrain offers some shelter or they remain offshore until the storm has passed. According to a native story, in the unusual spring of 1896 thousands of seals perished in ice floes which remained around the islands until late in June (Elliott, 1884). Aside from the observation that in mild seasons a few hundred stragglers, mostly males, remain about the Pribilofs well into the winter, a study of weather conditions there fails to reveal a correlation between

weather and the arrival and departure of the breeding animals. Except for the bodies of several hundred emaciated young seals that were washed ashore along the Washington, Oregon, and British Columbia coasts after a prolonged storm in the winter of 1950 (Scheffer, 1950c), we know little about the effect of inclement weather on seals at sea.

Mortality during migration.—According to returns of marked seals to the Pribilofs, about 70 per cent die from natural causes during the first three years of life. This estimate presumes that virtually all of the living three year old seals return to the Pribilof Islands. Mortality is undoubtedly highest in the first year when an estimated 50 per cent are lost.

Seals appear, although rarely, on the Pribilofs minus whole flippers or parts of flippers. In past years (but not recently) killer whales (*Grampus rectipinna*) were seen off the breeding grounds devouring seals (Hanna, 1922). Killer whales and possibly large sharks prey on seals but the writers believe adverse weather is the principal cause of mortality at sea. A number of beach specimens from the Pacific coast were saturated with crude oil, possibly a factor contributing to their death. As a matter of fact, little is known about mortality at sea.

Popular misconceptions of fur seal migration.—There is a widespread belief that fur seals travel at sea in large compact bands or herds. The basis for this belief apparently stems from two sources. (1) Evermann (1921) published a report by a lighthouse keeper, Mr. John Kundar, on the Farallon Islands, California, that on March 10, 1917 he observed a herd of 15,000 seals at sea, and that again on March 4, 1920 he observed a compact line of seals about three miles in length. He estimated this band contained 8,000 to 10,000 seals. The writers have spent many months at sea during all seasons and have never seen seals in large compact herds. They find no record by a reliable observer who has. Usually seals are seen singly (Plate I) and scattered loosely over a wide area, or else in small bands of five to eight but occasionally as many as fifteen together. Mr. Kundar probably misidentified a school of striped dolphins (*Lagenorhynchus obliquidens*) which congregate in great schools such as he described. (2) Annual newspaper stories that the U. S. Coast Guard Seal Patrol will "escort" the seal herd north to its summer breeding ground have added to the general impression that fur seals travel as a group. In actuality the Coast Guard vessels simply patrol the waters where fur seals are found. The fact that fur seals are extremely gregarious on their summer breeding grounds has little bearing on their rather solitary existence while at sea.

Arrival and departure of seals at the breeding grounds.—Although we know that in general the seals arrive at and leave the Pribilof Islands by age and sex classes, the mingling of the various classes on the breeding grounds makes it difficult to assign any exact dates. We know when the bulk of each group is present and approximately when each class begins to arrive. Studies which have been undertaken to date have failed to reveal (except as noted later) any definite relation between weather and arrival and departure of seals at the Pribilofs. We believe the stimulus causing migration is increasing or decreasing length of daylight, the same factor that initiates the movements of many other migratory animals and regulates reproduction and molt in most northern mammals.

During the late fall of 1941, biologists Wilke and A. Henry Banner recorded weekly counts as the seals deserted Kitovi and Lukanin rookeries. By the time the biologists began their counts on October 29, some animals had already left the rookeries, but the bulk of the population was still present. Table 2 gives a general picture of the rookery at a period when the seals are leaving in the greatest numbers. The last recorded observation was on December 9. Although the seals had almost entirely left Kitovi and Lukanin, there were still about 5,000 on Reef. Seals of all classes often remain as stragglers well into December. In fact, seal killings on the Pribilofs are recorded for every month of the year during the period when seals were killed for food if they were available (Bower, 1920–1925). However, it is evident that the majority of seals have left the Pribilof breeding areas and the vicinity of the islands by the first week in December.

The bulls are the first to reach the breeding grounds. The following early season records are taken as examples from the log book of St. George Island: 26 April 1890; 30 April 1891;

and 29 April 1893. These dates represent the first bull arriving on a rookery. In the early part of May the bulls begin arriving, slowly at first, then flowing toward the rookeries like a rapidly swelling stream until the middle of June. Only a small additional increase takes place by the end of the month. Table 1 lists the dates and the number of bulls present giving a rough picture of the arrival of bulls on Zapadni rookery, St. Paul Island, in 1944 (Scheffer, MS, 1944).

The bulls are the first to arrive in the spring and the last to leave in the winter. Table 2 shows the numbers of bulls on Kitovi rookery in 1941 (Wilke and Banner, MS) at a time when other classes of seals were rapidly departing. The bull class leaves the breeding area proper more slowly than seals of other age and sex groups and, in addition, the bulls gather for long periods of rest on the hauling grounds after deserting the rookeries.

After the bulls are well established on the rookeries, the cows arrive. They appear in numbers after the middle of June and continue to haul out with increasing frequency until mid-July. When Scheffer visited Zapadni rookery on June 9, 1944, one cow was present.

TABLE 1.—*Number of bulls present on successive dates on Zapadni rookery, St. Paul Island, 1944.*

DATE	BULLS COUNTED	DATE	BULLS COUNTED
May 16	18	June 19	1,068
26	126	29	1,221
June 3	343	July 9	1,036
9	500	18	1,214

TABLE 2.—*Counts of seals on Lukanin and Kitovi rookeries, St. Paul Island, Alaska (Wilke and Banner, MS, 1941)*

DATE	BULLS COUNTED	COWS COUNTED	PUPS COUNTED
October 29	62	1,680	1,410
November 6	90	1,260	2,190
November 13	80	950	920
November 20	73	540	266
November 26	48	117	41
December 3	23	0	1

By June 19, 150 had arrived, and by mid-July over 25,000. The non-breeding cows, most of them less than four years of age, arrive during August, September, and October.

During the latter part of October the cows begin to leave the rookeries for the winter. Undoubtedly, some leave unobserved earlier. Table 2 illustrates the trend of departures. Although these counts do not give us a complete picture of the entire situation on the breeding islands they are an indication of the rapid fall exodus. Cows still remained on other rookeries after this count was taken and many of those that had departed from land were near the island for several days longer.

Young males arrive on the islands in order of decreasing age, the youngest last. In general, the maximum numbers of seals older than three years arrive before mid-July. The number of three year olds reaches a maximum after the middle of July. Many of the bachelors leave at about the same time as the cows and pups but some remain about the islands well into December. The winter of 1949–50 was mild on the Pribilofs with a higher than average temperature and little snow. Several hundred seals were still about St. Paul rookeries after the first of February.

It is difficult to distinguish between yearling and two-year old seals in the field. A few

two-year old males are picked up during sealing drives throughout the commercial season on the Pribilofs. However, during the latter part of July they are present in such numbers that they seriously interfere with sealing operations. After the first of August the hauling grounds become progressively more crowded with them. Beginning in late August the two-year old cows begin to arrive on the rookeries, but the greatest number are not present until October. The yearling seals visit the breeding grounds late in the season, from September to November. Apparently the homing tendency is weakly developed and the majority of seals remain at sea during the first year and a half of their lives.

The height of the pupping season is in the middle of July, and the pups usually take to the water about August 10. Weaning is rather abrupt and takes place when a mother simply departs on her southward migration sometime between September and December. Pups and cows depart at about the same time but we have never seen, either at sea or in the vicinity of the Pribilofs, any indication that pups leave with their mothers or travel with them at sea. In early October the pups become restless. Several that were tagged on Zapadni

TABLE 3.—*Tag recoveries (all tagged on St. Paul Island)*

WHERE RECOVERED	HOW RECOVERED	NO. SPECIMENS	AGE OF SPECIMENS WHEN RECOVERED
Russia—			
Commander Islands			
Bering Island	Commercial kill?	2	4 & 2 yrs.
Copper Islands	Commercial kill?	2	2 yrs.
Japan—			
off Honshu	Pelagic kill and fish nets	11	9 mos. to 2 yrs. 9 mos.
off Hokkaido		1	9 mos.
West coast of U. S. and Canada			
Vancouver, B.C.	Found dead on beach	3	6 to 10 mos.
Washington	Found dead on beach	13	6 to 10 mos.
Oregon	Found dead on beach	19	6 to 10 mos.
California	Found dead on beach	1	6 to 10 mos.
Pribilof Islands			
St. George Island	Commercial kills	78+	Mostly 3, some 2 & 4 yrs.
St. Paul Island	Commercial kills and scientific specimens	5,000 (Approx.)	All ages, 1 yr. to 21 yrs.

rookery were subsequently found wandering about on Tolstoi two days later and about two miles distant. The departure of pups from Kitovi rookery (Table 2) illustrates the trend.

Recoveries of tagged seals.—Since 1927 approximately 70,000 seals have been tagged or branded on the Pribilof Islands. By far the majority of these marked animals have been recovered on the Pribilofs where they have furnished specimens of known age for growth, mortality, and population studies. They have also furnished data which lead to the conclusion that, although young male seals two or three years of age haul out somewhat indiscriminately on various rookeries, they tend to return in increasing proportions, as they mature, to the rookeries of their birth (Table 4). In the summer of 1950, 1,307 three-year-old males tagged in 1947 were recovered on St. Paul, the island of their birth, while only 24 animals tagged on St. Paul were taken on St. George Island, 40 miles away.

Unfortunately for our knowledge of seal migration, tags gathered away from the Pribilofs (Table 3), are comparatively scarce. Thirty-six young seals, tagged during the previous summer on the Pribilofs have been picked up during winter months on the beaches of Washington and Oregon nearly 2,000 miles away (Scheffer, 1950c). Four young males tagged as

pups on the Pribilofs are reported as having been recovered among seals taken on the Commander Islands of Russia (Scheffer, 1950*a*). Twelve have been recovered from seals taken off the Japanese coast (Austin and Wilke, 1950; Wilke, 1951) as in Table 3. Other tag recoveries (Anonymous Japanese Report, 1933), unsubstantiated by actual exhibition of the tags, have been reported by the Japanese. It is reasonable to believe that more tags have been recovered than have been turned in to officials of the central Japanese government.

The homing instinct as revealed by tag returns.—The return of every marked seal appearing in the commercial kills each season is recorded. Females are not taken commercially except

TABLE 4.—*Return of seals to rookery of birth as shown by tagged seals recovered*

AGES OF SEALS	MALES		FEMALES	
	Total no.	Percent of recoveries on hauling ground of home rookery	Total no.	Percent of recoveries on home rookery
1	1	0	0	0
2	328	34	8	100
3	1,425	60	10	100
4	613	68	7	100
5	11	73	3	100
6	21	86	3	66
7	6	100	2	100
8	2	100	2	100
9	—	—	1	100
10	2	100	2	100

TABLE 5.—*Variations in the development of the homing instinct in male seals originating on different rookeries**

ROOKERY-GROUP OF BIRTH†	NO. OF RECOVERIES		PERCENT RETURN TO HOME ROOKERY	
	3-yr. olds	4-yr. olds	3-yr. olds	4-yr. olds
Northeast Point	369	114	85	95
Polovina Group	280	110	70	78
Zapadni Group	302	105	65	81
Reef Group	247	109	36	34
Tolstoi	69	26	28	46

* A-tag series, 3-year olds, taken in 1950 and A-tag series, 4-year olds, taken in 1951.
† Exclusive of Lukanin-Kitovi.

by accident, so only those tagged animals taken as study specimens are available. In spite of the dearth of specimens it appears that the homing instinct of females (Table 4) develops earlier than in males. Females are generally bred at three or four years of age, while males do not take up a permanent position on the breeding grounds to become active breeders until some time between the ages of seven and ten. Thus development of the homing instinct appears to be associated with maturity.

The tendency of seals three and four years old to return to the rookery of their birth varies from 28 per cent return on Tolstoi to 85 per cent at Northeast Point for seals tagged in 1947 and recovered at age three (Table 5). Causative factors suggested by way of explanation are: (1) Topography. Rough ground at the extremities of the harem areas makes it

difficult for the young males to make their way through or around the breeding groups of seals to the hauling grounds and therefore they wander to other areas. (2) Gregariousness. Northeast Point is a large and spacious rookery which not only draws most of its own seals back at an early age but also draws them from all other rookeries. (3) Prevailing weather conditions. Seals obviously desert areas that are exposed to wind and rain, and gather on areas offering shelter. These factors, either separately or in combination, appear to influence the young non-breeding seals in their selection of a landing place. Few specimens over four years of age have been collected.

SUMMARY

C. H. Townsend's digest of the pelagic sealing records gives a good general indication of the distribution of the several groups of northern fur seals during their winter migration. However, in Townsend's time it was not known that seals from the various breeding grounds mingled to some extent on migration. Recent observations indicate that the seals are more widely scattered on migration than was formerly recorded. The recovery of Pribilof tagged seals from the Asiatic side of the North Pacific requires a revision of the traditional belief that seals originating on the Pribilof Islands migrate only to the waters off the North American coast.

Fur seals migrate loosely. Some leave the Pribilofs in October, others do not leave until December, some may occasionally remain near the breeding islands during all months of the year, while others travel southward nearly 3,000 miles. During the period when they are at sea, seals are found concurrently in the Aleutians and as far south as the United States–Mexican border, in the North Pacific, and off the Japanese coast. Adult females and young animals of both sexes travel farthest. Adult males usually remain in northern waters. In winter certain adult females may separate from younger females and males at sea and enter straits and inlets along the outer coast of southeastern Alaska to feed. Different sexes and age classes tend to segregate themselves to some extent on the open sea. Seals on migration are seen singly or, at times when relatively concentrated, in small bands of from five to fifteen animals. No authentic records are available of large compact assemblages of fur seals at sea.

Male fur seals tend to return to the exact place of their birth with increasing frequency as they approach maturity. Data available indicate that young females return to their home rookery with greater frequency, and at an earlier age, than young males. Several seals tagged on St. Paul were recovered from St. George Island of the Pribilof Group and the Commander Islands of Russia.

During migration away from the Pribilof Islands fur seals are known to come ashore on one small Aleutian Island and elsewhere, in insignificant numbers, only when sick or injured. Natural mortality during the first years is 70 per cent.

Off Japan, seals were most numerous in water with a surface temperature between 47 and 54°F. The relative roles of water temperature and food abundance in attracting fur seals are uncertain. An attractive food supply at Crawfish Inlet in southeastern Alaska induces female seals to remain in colder water (38° F.). Attempts to correlate the distribution of fur seals with commercial

fishing banks have shown no consistent relationship. For the most part the animals feed over deep water, taking pelagic or demersal fish and squid that rise to the surface at night. Fur seals while on migration are generally found from ten to fifty miles at sea, in water often several thousand feet in depth. Occasional strays are reported from bays and rivers.

LITERATURE CITED

Anonymous Japanese Report. 1933. Migration of Pribilof fur seals into the waters off the coast of Japan. Bur. of Fish., Min. of Agr. and Forestry, Japan. 21 p.

Austin, O. L., Jr., and F. Wilke. 1950. Japanese fur sealing. Natural Resources Section Report No. 129. Tokyo, Japan. 91 p.

Bernard, J. F. 1925. Farthest north record of fur seal. Murrelet, 6: 14.

Bower, W. T. 1920, 1921, 1922, 1923, and 1925. Alaksa fisheries and fur seal industries in 1919, 1920, 1921, 1922, and 1923. U. S. Bur. Fish. Doc. 891, 909, 933, 951, and 973.

Brooks, A. 1937. Fur seals off California. Jour. Mamm., 18: 99.

Clemens, W. A., and G. V. Wilby. 1933. Food of the fur seal off the coast of British Columbia. Jour. Mamm., 14: 43–46.

Clemens, W. A., J. L. Hart, and G. V. Wilby. 1936. Analysis of stomach contents of fur seals taken off the west coast of Vancouver Island in April and May, 1935. Published by the Dept. of Fish., Ottawa, Canada.

Elliott, H. W. 1884. Report of the seal islands of Alaska. U. S. Census Office, 10th Census, 1880. Census Reports, Washington, D. C.

Evermann, B. W. 1921. Fur seals off the Farallones. Science N. S., 54: 547–548.

Hall, E. R. 1940. Pribilof fur seal on California coast. Calif. Fish and Game, 26: 76–77.

Hanna, G. D. 1920. Mammals of the St. Matthew Islands, Bering Sea. Jour. Mamm., 1: 118–122.

———. 1922. What becomes of the fur seals. Science N. S., 55: 505–507.

———. 1951. Alaska fur seals, *Callorhinus ursinus*, observed off San Francisco Bay, California. Jour. Mamm., 32: 364–365.

Hooper, C. L. 1892. Manuscript report of the cruise of the steamer *Corwin*, November 21, 1892.

Huey, L. N. 1942. Pribilof fur seal taken in San Diego County, California. Jour. Mamm., 23: 95–96.

Jewett, S. W. 1921. Pribilof fur seal on the Oregon coast. Jour. Mamm., 2: 235.

———. 1925. Second occurrence of the Pribilof fur seal on the Oregon coast. Jour. Mamm., 6: 200.

———. 1930. A third record of the fur seal on the Oregon coast. Jour. Mamm., 11: 314.

———. 1933. A fourth record of the Pribilof fur seal on the Oregon coast. Jour. Mamm., 14: 269.

Jordan, D. S. 1898–99. The fur seals and fur-seal islands of the North Pacific Ocean. Government Printing Office, Washington, Treasury Dept. Doc. 2017, 4 vols.

Scheffer, V. B. 1939. Fur seal in Willapa Harbor. Murrelet, 20: 43.

———. 1946. How deep will a fur seal dive? Murrelet, 27: 25.

———. 1950*a*. Experiments in the marking of seals and sea lions. Spec. Sci. Report, Wildlife No. 4, U. S. Fish and Wildlife Service.

———. 1950*b*. Growth layers on the teeth of Pinnipedia as an indication of age. Science, 112: 309–311.

———. 1950*c*. Winter injury to young fur seals on the northwest coast. Calif. Fish and Game, 36: 378–379.

Schultz, L. P., and A. M. Rafn. 1936. Stomach contents of fur seals taken off the coast of Washington. Jour. Mamm., 17: 13–15.

TANNER, Z. L. 1883. Occurrence of fur seals in mid-ocean. Bull. U. S. Fish. Comm. for 1882, 2: 216.

WILKE, F. 1951. Pelagic fur seal research off Japan in 1950. Natural Resources Section, Pre. Study No. 67. Tokyo, Japan, October.

WILKE, F. AND K. W. KENYON. 1952. Notes on the food of fur seal, sea-lion, and harbor porpoise. Jour. Wildlife Mgt., 16: 396–397.

Fish and Wildlife Service, 2725 Montlake Boulevard, Seattle 2, Washington. Received February 15, 1952.

TWO RECORDS OF *BERARDIUS BAIRDI* FROM THE COAST OF BRITISH COLUMBIA

BY GORDON C. PIKE

During 1950 and 1951 two Baird's beaked whales, *Berardius bairdi* Stejneger, were harpooned off the northwest coast of Vancouver Island and subsequently processed at the shore whaling station operated by British Columbia Packers Company Limited at Coal Harbour, British Columbia. The first, a 33-foot adult male, was taken on July 5, 1950 about 10 miles off Kains Island, Quatsino Sound. The second, a 29-foot immature female, was taken on August 9, 1951, 20 miles ESE of Cape St. James. The two specimens are the first records of this species from the coast of British Columbia.

Berardius bairdi, one of the little known members of the whale family Ziphiidae, has previously been recorded from California, Washington, the Bering Sea, and Japan. Records of the species from the eastern North Pacific are rare, but in waters adjacent to Japan over 300 were taken commercially under the name of "Tsushi-kujira" in 1949 and 1950 (Japan Whaling Association, 1951).

In general, the external form of the two British Columbia specimens corresponds to previous descriptions of the species as compiled by True (1910). A narrow elongated snout extends forward from a well-defined forehead. The body tapers from its greatest girth between the flippers and the dorsal fin to a slender tail region terminated by broad flukes (Plate I, 1 and 2). The flippers are small (Plate I, 4). The dorsal fin is small and is situated well behind the middle of the body (Plate I, 3). The lower jaw, armed with only two inconspicuous pairs of teeth, extends slightly beyond the tip of the toothless upper jaw. The V-shaped grooves beneath the chin, characteristic of the Ziphiidae, are deep and well defined (Plate I, 1). In the male specimen the forehead rises abruptly almost at right angles to the beak from a distinct transverse groove (Plate I, 5). In the female the bulge on the forehead is less prominent and no transverse groove is apparent.

In these specimens the body is black on the head, back, flukes and flippers. The undersurface is of a slightly lighter shade, with white and gray markings. The male has a conspicuous diamond-shaped white patch at the umbilicus and some white around the genital opening. The female is lighter in colour and the skin was covered by abrasions caused while the whale was being towed into the station. Numerous white scratch marks appear on the back and flanks of both

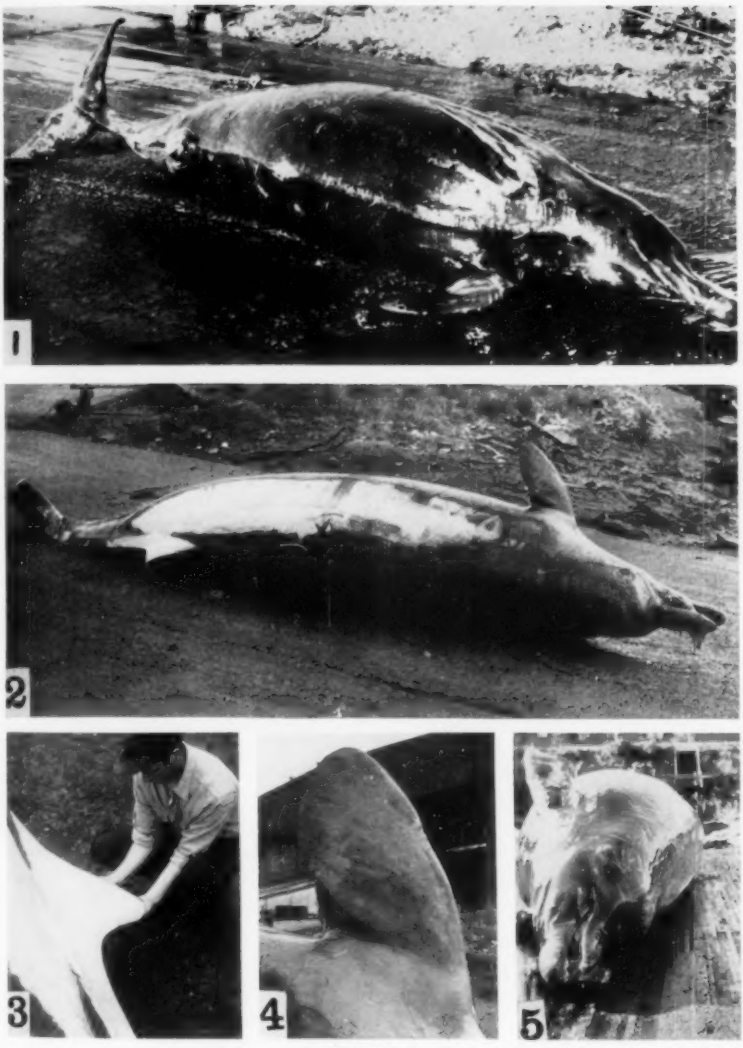


PLATE I

(1) Ventral view of 33-foot male *Berardius bairdi*. (2) Dorsal view of 29-foot female. (3) Dorsal fin of 29-foot female. (4) Left flipper of 29-foot female. (5) Head view of 33-foot male.

specimens (Plate I, 5). These scratch marks, when found on males of other Ziphiidae and Delphinidae, have been attributed to the teeth of rival males. This

explanation seems unlikely to be applicable to this species whose teeth are either buried in the gum or are blunt and protrude only slightly. A more plausible explanation for all species is that the scratches are caused by the sharp "beaks" of the squid on which they feed. Similar scratches are found on the heads of sperm whales.

The external features of these specimens differ only in minor particulars from the descriptions compiled by True (1910). The flippers are not pointed, but are similar to those of the sperm whale (Plate I, 3). Unlike other Ziphiidae, the posterior emargination of the dorsal fin is not concave (Plate I, 4). The female has a slightly concave hind margin to the flukes and the male has a median notch nine inches deep in the hind margin of the flukes. A characteristic of the Ziphiidae is that the hind margin of the flukes is slightly convex with no median notch. Although the notch in the male appeared to be natural, it may well have been the result of an early injury.

The V-shaped throat grooves in the male specimen are each 26 inches in length; they converge and almost meet at a point 17 inches from the tip of the lower jaw (Plate I, 1). A short but deep median groove six inches long commences 22 inches from the tip of the lower jaw. The throat grooves in the female are each 24 inches long, commencing 16 inches from the tip of the jaw. The two grooves are two inches apart at the posterior extremity; no median groove separates them as in the male.

Measurements of body proportions are presented in Table 1 in feet and inches and as percentages of the total length from the tip of the snout to the hind margin of the flukes. The series of measurements is based upon that used by the British Discovery Committee for describing the larger commercial species of whales (Mackintosh and Wheeler, 1929). Comparison of measurements for the two specimens shows clearly that the head is relatively larger, the flipper smaller, and the dorsal fin slightly larger for the female than for the male. The breadth of the body behind the flippers appears to be greater in the female.

Table 2 compares selected body measurements of the two British Columbia specimens with those from two specimens of *Berardius bairdi* from St. George Island and one specimen of *B. arnuxi* from New Zealand, as percentages of the total length (True, 1910). The values correspond closely for all the North Pacific specimens. The discrepancy in the value of "tip of mandible to corner of mouth" for the female specimen is probably a result of the poorly defined point, "corner of mouth". The comparison bears out True's observation that the flukes are wider and the flippers longer in *Berardius bairdi* than in *B. arnuxi*.

A character used by True and others to distinguish *Berardius bairdi* from *B. arnuxi* is the relative size of the head, which is said to approximate one–eighth of the total length in the former species and one–seventh in the latter species. Table 3 shows the extreme variability of this character and suggests its unreliability as a diagnostic feature. Relative skull lengths in these specimens vary from less than one–seventh to more than one–eighth of the total length.

Measurements of the skulls, which are being retained at the Pacific Biological Station, Nanaimo, British Columbia, are presented in Table 5 in millimetres and

as percentages of the postorbital width. Proportions are not given as percentages of the total length because a small part of the premaxillary tips were broken off during the process of cleaning the male specimen. These tips are extremely fragile and are probably damaged to some extent in most specimens. The comparison shows the female skull to be more robust than the male skull.

TABLE I.—*Measurements and body proportions of Berardius bairdi from British Columbia*

	MALE			FEMALE		
	FT.	IN.	% OF TOTAL LENGTH	FT.	IN.	% OF TOTAL LENGTH
Total length from tip of snout to hind margin of flukes	33	3	100.0	29	3	100.0
Projection of lower jaw beyond tip of snout	—	4	1.0	—	1	0.3
Tip of snout to blow-hole	3	8	11.0	3	7	12.2
Tip of snout to angle of gape	2	1	6.3	2	2	7.4
Tip of snout to centre of eye	3	6	10.5	3	7	12.2
Tip of snout to tip of flipper	10	5	31.3	9	3	31.6
Hind margin of flukes to posterior emargination of dorsal fin	10	5	31.3	9	6	32.5
Width of flukes at insertion	2	9	8.3	2	3	7.7
Hind margin of flukes to anus	10	2	30.6	9	0	30.8
Hind margin of flukes to umbilicus	19	6	58.6	17	2	58.7
Centre of reproduction aperture to centre of anus	2	6	7.5	—	—	—
Height of dorsal fin	—	9	2.3	—	9	2.6
Length of base of dorsal fin	2	3	6.8	2	2	7.4
Axilla to tip of flipper	2	9	8.3	2	6	8.5
Tip to anterior end of lower border of flipper	4	4	13.0	3	6	12.0
Length along curve of lower border to tip of flipper	4	5	13.3	3	10	13.1
Greatest width of flipper	1	5	4.3	1	4	4.5
Length of severed head from condyle to tip	4	9	14.3	4	7	15.7
Length of flipper from head of humerus to tip	4	2	12.5	3	6	12.0
Depth of body at dorsal fin	6	3	18.8	4	4	14.8
Total spread of flukes	9	6	28.6	—	—	—
Width across blow-hole	—	6	1.5	—	7	2.0
Tip of snout to forehead groove	2	5	7.3	2	0	6.8
Breadth of body at flippers (including flippers)	3	8	11.0	—	—	—
Breadth of body at blow-hole	3	0	9.0	3	2	10.8
Blubber thickness on flank in line with dorsal fin	—	3.5	1.1	—	4	1.3

The two pairs of teeth are roughly triangular in side view, with rugose bases insecurely attached by closed roots in their alveoli. The teeth protrude slightly above the gum in the male but are completely buried in the female. The apices of the larger anterior pairs are considerably abraded in the male but are sharply acute in the female. A shallow, median, longitudinal groove in the base of each

tooth from the female suggest that the sides had recently drawn together to form closed roots. Measurements of the teeth and their positions on the mandibles are presented in Table 4.

Stomach contents of the male consisted of a few hard and soft parts of small squid and a single skate egg case. The food, about two gallons in all, was accompanied by numerous nematodes. Stomach contents of the female consisted of about two gallons of small rockfish and squid remains accompanied by a few nematodes. The only external parasites were a few caprellid amphipods similar to the species of *Paracyamus* commonly occurring on humpback whales. These were found only on the male and were concentrated chiefly in the region of the teeth. The skin of the female was invested by a film of diatoms consisting of ex-

TABLE 2.—*Body proportions of Berardius bairdi and Berardius arnuxi*

	BAIRDI				ARNUXI
	BRITISH COLUMBIA		U.S.N.M. 49726	U.S.N.M. 49727	NEW ZEALAND (HECTOR)
	ADULT ♂	YOUNG ♀	ADULT ♀	YOUNG ♂	MALE
Total length	ft. in. 33 3	ft. in. 29 3	ft. in. 40 2	ft. in. 25 5	ft. in. 27 6
	%	%	%	%	%
Distance from tip of snout to blow-hole	11.0	12.2	10.8	11.5	12.8
Distance from tip of mandible to corner of mouth	6.3	7.4	6.9	6.3	6.1
Length of pectoral fin along outer edge	13.0	12.0	12.4	13.4	9.4
Breadth of flukes from tip to tip	28.6	—	25.3	24.6	19.1
Height of dorsal fin	2.3	2.6	2.5	2.4	3.0
Distance from anus to "end of body"	30.6	30.8	29.0	29.8	(34.0)

TABLE 3.—*Head lengths of Berardius bairdi*

LOCALITY	SEX	TOTAL LENGTH (FT.	IN.)	SKULL LENGTH (MM.)	SKULL LENGTH: TOTAL LENGTH (PER CENT)
British Columbia	Female	29	3	1343	15.1
Ocean City, Wash.	Female	34	5	1438	13.7
St. George Island	Female	40	2	1524	12.4
St. George Island	Male	25	5	1062 (?)	13.7
British Columbia	Male	33	3	1440	14.2
Centerville, Calif.	Male (?)	41	0	1532	12.3

TABLE 4.—*Teeth of British Columbia specimens of Berardius bairdi*

	DISTANCE BETWEEN APICES OF 1ST AND 2ND TEETH IN MM.	LARGE TOOTH		SMALL TOOTH	
		GREATEST HEIGHT MM.	GREATEST BREADTH MM.	GREATEST HEIGHT MM.	GREATEST BREADTH MM.
33-ft. male	151	89	103	60	37
29-ft. female	140	93	72	55	33

tensive brown areas of *Cocconeis* and small dispersed centres of *Navicula*. Two fresh marks of the Pacific lamprey, *Entosphenus tridentatus*, were found on the female. Neither diatoms nor lamprey marks were noted on the male.

Examination of the degree of fusion of the epiphyses of the thoracic vertebrae with their centra showed the male to be physically mature and the female to be physically immature. The female was also sexually immature. Its ovaries, weigh-

TABLE 5.—*Skull measurements of Berardius bairdi from British Columbia*

	LENGTH IN MM.		PER CENT OF POSTORBITAL WIDTH	
	33 FT. ♂	29 FT. ♀	33 FT. ♂	29 FT. ♀
Total (condylobasal) length	1,440	1,343	187.0	203.8
Height from vertex to inferior border of pterygoids	569	525	73.9	79.7
Breadth across middle of orbits	693	657	90.0	99.7
Breadth across postorbital processes	*770*	*659*	*100.0*	*100.0*
Breadth across zygomatic processes	732	660	95.0	100.2
Length of rostrum	908	870	117.0	132.0
Breadth of rostrum at base	447	397	58.1	60.2
Breadth of rostrum at middle	208	194	27.0	29.4
Length of premaxilla	1,220	1,192	158.4	180.9
Breadth of premaxilla at middle	132	138	17.1	20.9
Greatest breadth of premaxillae in front of nares	238	239	30.9	36.3
Greatest breadth of premaxillae behind nares	204	203	26.5	30.8
Distance from anterior end of premaxillae to posterior end of pterygoids (median)	1,146	865	148.8	131.3
Distance from anterior end of premaxillae to anterior end of vomer	263(?)	280	34.2	42.5
Length of portion of vomer visible on palate	438	354	56.9	53.7
Length of nasals (greatest, median, straight)	120	110	15.6	16.7
Breadth of nasals (greatest)	110	125	14.3	19.0
Breadth of anterior nares	98	94	12.7	14.3
Breadth of foramen magnum	86	72	11.2	10.9
Breadth across occipital condyles	246	216	31.9	32.8
Breadth of each condyle	115	100	14.9	15.2
Height of each condyle	180	173	23.4	26.3
Length of mandible	1,334	1,190	173.2	180.6
Height of coronoid	241	212	31.3	32.2
Distance from tip of jaw to centre of 1st tooth	38	30	4.9	4.6
Distance from tip of jaw to centre of 2nd tooth	189	170	24.5	25.8
Least depth of mandible behind 1st tooth	110	93	14.3	14.1
Ventral face to apex of 1st tooth crown	138	98	17.9	14.9

ing less than two ounces each, contained no corpora lutea or maturing follicles. The testes of the male were not found but it is presumed that the animal was sexually adult.

Some information concerning the habits of this species is provided by members of the whaling crews responsible for the capture of the two specimens. The school from which the male was taken consisted of about 20 individuals, many of them larger than the one captured. Upon surfacing, all members of the school except

one, a large animal which appeared to be the leader, seemed to rush together. The leader remained about 100 yards from the rest of the school and dived independently. From a distance, and before being approached, the whales were seen to raise their flukes in the air like sperms when diving. The blows numbered about fifteen in quick succession. The female was taken from a school of about 20 individuals and two other schools about the same size were in the vicinity at the time. No leaders were observed but numerous calves were seen. Attesting to the agility and deep-diving propensities of this species is the fact that the male, when struck by the harpoon, dived straight down at an amazing speed, taking with it 500 fathoms of line.

The limited number of records of *Berardius bairdi* reflects in part a lack of attention paid the beaked whales. British Columbia whalers report that schools of this species are commonly seen in July and August. Barabash-Nikiforov (1938) reports that *Berardius* often forms large schools in the vicinity of the Commander Islands. Recent records of the species include a 34-foot adult female washed ashore at Ocean City, Washington in July, 1950 (Slipp and Wilke, 1953), and a 34-foot male taken from a school of about twenty at the Eureka whaling station in California in May, 1951. Whales from this coast reported as "Bottlenose" are probably *Berardius*, as the true "bottlenose", *Hyperoodon*, has never been certainly recorded from the North Pacific (Slipp and Wilke, 1952). Prewar whaling statistics for the west coast of North America show the catch of eight "bottlenosed whales" at Bay City, Washington, and seven from the coast of British Columbia (Kellogg, 1931; Scheffer and Slipp, 1948).

LITERATURE CITED

Barabash-Nikiforov, I. 1938. Mammals of the Commander Islands and the surrounding sea. Jour. Mamm., 19: 423–429.

Japan Whaling Association. 1951. Some materials showing the status of whaling of Japan. Fisheries Agency of the Japanese Govt., Tokyo, Japan. 31 p.

Kellogg, R. 1931. Whaling statistics for the Pacific Coast of North America. Jour. Mamm., 12: 73–77.

Mackintosh, N. R. and J. F. G. Wheeler. 1929. Southern blue and fin whales. Disc. Repts., 1: 257–540

Scheffer, V. B. and J. W. Slipp. 1948. The whales and dolphins of Washington State with a key to the cetaceans of the west coast of North America. Amer. Mid. Nat., 39: 257–337.

Scheffer, V. B. 1949. Notes on three beaked whales from the Aleutian Islands. Pac. Sci., 3: 353.

Slipp, J. W. and F. Wilke. 1953. The ziphiid whale *Berardius* on the Washington coast. Jour. Mamm., (this issue).

True, F. W. 1910. Account of the beaked whales of the family Ziphiidae in the collection of the United States National Museum, with remarks on some specimens in other American museums. Bul. U. S. Mus. Nat. Hist., 73: 1–89.

Pacific Biological Station, Nanaimo, British Columbia. Received February 11, 1952.

THE BEAKED WHALE *BERARDIUS* ON THE WASHINGTON COAST

By J. W. Slipp and Ford Wilke

Beaked whales of the genus *Berardius* are considered to comprise two little understood species, *B. arnuxi* Duverney, 1851, of the Antarctic Ocean and adjacent waters, and *B. bairdi* Stejneger, 1883, of the North Pacific (Japan and California north to the Bering Sea). They are unique among ziphiids in several ways, one of which is their large size, their closest rivals in this respect being the male bottlenosed whales of the genus *Hyperoodon*. Thus far very few American specimens of the genus have been critically examined and reported. As a result of a recent stranding, we are able to supply the following account of the first such specimen from the coast of the State of Washington.

Dr. Victor B. Scheffer and Karl W. Kenyon of the U. S. Fish and Wildlife Service, and Dr. Remington Kellogg of the U. S. National Museum have aided us materially in completing this report. The work has been carried on as a joint project of the U. S. Fish and Wildlife Service, Branch of Wildlife Research, and the University of Washington Fisheries research program. Late drafts of the manuscript have been read and criticized by Gordon Pike of the Pacific Biological Station at Nanaimo, Dr. Johan T. Ruud of the University of Oslo and the State Institute for Whaling Research, and Dr. Raymond M. Gilmore of the U. S. Fish and Wildlife Service.

Early in July 1950, the body of a large beaked whale floated onto the beach about a mile south of Ocean City, Washington, and about seven miles north of the mouth of Grays Harbor. In the ensuing weeks a great many people viewed the carcass in progressive stages of decay, and several took photographs which were submitted to us for identification (Pl. I). Souvenir hunters early hacked off the end of the lower jaw and extracted the teeth. Garbled press reports appeared in some of the newspapers of the region. On August 16 one of us visited the carcass and obtained one of the mutilated mandibles, which by this time could easily be pulled free from the rotting flesh. On August 21 we visited the scene together, made certain measurements, and obtained an assortment of skeletal elements, including the skull. The condition of the body and its position in the sand precluded the taking of adequate field data. However, the specimen was judged on the basis of skeletal condition to be physically adult, and its color to have been entirely black or blackish on all exposed surfaces. Careful measurement showed it to be 10.50 meters (34.45 feet) in length from tip of snout to center of frayed trailing edge of flukes. The flukes were so badly abraded at their extremities that accurate measurement was impossible, but the spread of the remaining portion (238 cm.) provided a basis for estimating the original spread as at best about 244 cm.. The right flipper measured 87 cm. from axilla to tip, with a maximum breadth of 36 cm..

The skeletal elements obtained were the following: skull and mandibles, the right stylohyal, the fused cervical block, the first caudal vertebra with associated chevrons (occupying position 17 counting forward from the terminal caudal

vertebra), the terminal nine caudal vertebrae, the entire left flipper and scapula, and the right antebrachium and manus. These have been cleaned and are deposited at the University of Washington, Seattle, in the new Fisheries Building, pending final action on proposals for the establishment there of a permanent collection of marine mammals. The dimensions of the skull and mandibles (Pl. II) taken as prescribed by True (1910) are contained in Table 1 in which, for future convenience, all measurements are further expressed as percentages of the total or condylobasal length and of the maximum or postorbital breadth of

PLATE I

Decomposing carcass of *Berardius* on beach near Ocean City, Washington, summer 1950. (Photo. courtesy of W. R. Southworth)
(INSERT) Head of *Berardius bairdi* at whaling station in Abashiri, Hokkaido, Japan. (FW photo.)

the skull. The latter is a more durable reference dimension, i.e. less subject to alteration in beachworn or otherwise eroded specimens.

The large size and robustness of this skull suggests to us that the specimen was a female, the usual ziphiid size relationship between the sexes apparently being reversed in *Berardius* (Tomilin, 1938; Matsuura, 1942; Pike, 1952). It will be noted that the skull length is 13.7%, or a little less than one-seventh of the recorded total length, approximating the ratio ascribed to *B. arnuxi* (one-seventh) rather than that of *B. bairdi* (one-eighth) (Norman and Fraser, 1949: 274; but see also Pike, 1952). Other characters supposedly diagnostic of *B. arnuxi* as listed by True (1910) apply in varying degree to the present specimen,

PLATE II

Lateral, dorsal, and ventral views (top to bottom) of skull of *Berardius* stranded near Ocean City, Washington. (JWS photos.)

raising the question of identity and suggesting that the two species may be less well-marked than previously supposed. Accordingly, we have consulted as much of the available literature as possible (see bibliography) and have submitted the bulk of our records to Dr. Remington Kellogg of the U. S. National Museum who comments as follows (letter of March 22, 1951): "The *Berardius* material in this Museum includes one skull of *arnuxii* (No. 21511) and five skulls of *bairdii*. The measurements of the Ocean City skull, and particularly the total length

TABLE 1.—*Skull dimensions of a specimen of Berardius bairdi from Ocean City, Washington*

MEASUREMENT	MM.	PER CENT OF TOTAL LENGTH	PER CENT OF WIDTH
Total (condylobasal) length	1438	*100.0*	181.8
Height of skull, rostral axis level	564	39.2	71.3
Vertex to inferior border of pterygoids	582	40.5	73.6
Breadth across middle of orbits	757	52.6	83.2
Breadth across postorbital processes	791	55.0	100.0
Breadth across zygomatic processes	748	52.0	94.6
Length of rostrum (to apices of ant. notches)	923	64.2	116.7
Breadth of rostrum at base (anterior notches)	445	30.9	56.3
Breadth of rostrum at middle	206	14.3	26.0
Length of premaxillae (maximum visible)	1286	89.4	162.6
Breadth of premaxillae at middle of rostrum	124	08.6	15.7
Greatest breadth of premaxillae in front of nares (anterior border)	246	17.1	31.1
Greatest breadth of premaxillae behind nares	215	15.0	27.2
Distance from anterior end of premaxillae to posterior end of pterygoids (median)	1122	78.0	141.8
Distance from anterior end of premaxillae to anterior end of vomer (end broken)	291	20.2	36.8
Length of portion of vomer visible on palate	446	31.0	56.4
Length of nasals (greatest, median, straight)	135	09.4	17.1
Breadth of nasals (greatest)	131	09.1	16.6
Breadth of anterior nares	102	07.1	12.9
Breadth of foramen magnum (caliper passage)	78	05.4	09.9
Breadth of occipital condyles	221	15.4	27.9
Breadth of left condyle	101	07.0	12.8
Breadth of right condyle	110	07.6	13.9
Maximum length of left condyle	170	11.8	21.5
Maximum length of right condyle	171	11.8	21.6
Height of left mandible at coronoid	222	15.4	28.1
Height of right mandible at coronoid	223	15.5	28.2

(144 cm.) indicate an adult. In general contour, however, the photograph indicates a skull which resembles the skull of an immature male *bairdii* (No. 49727) more closely than those of adults. This resemblance may in part be attributed to the position when photographed. Direct comparison of your photographs with four skulls of *bairdii* and with one of *arnuxii* nevertheless lead me to conclude that the relationships are with the former rather than with the latter.

"Unfortunately, the skulls of some cetaceans at least seem to grow through-

out life and individual bones change somewhat in configuration from youth to old age. So far as can be judged from the five *bairdii* skulls in this Museum, the breadth of the rostrum at the base (between antorbital notches) seems to vary considerably. (See True, Bull. 73, 1910, pl. 27). The nasal bones, jugals and lachrymals are altered with age. Sex may account for other observed differences.

"The right periotic of the Ocean City skull presents no essential differences from that of *bairdii*. Only one periotic of *bairdii* was located in the collection and

TABLE 2.—*Selected skeletal dimensions in millimeters of specimens of Berardius*

MEASUREMENTS	SP. ? OCEAN CITY, 34′5″ AD. ♀?	ARNUXI FLOWER NEW ZEALAND CA. 30′ IM. ♀	BAIRDI PRIBILOF I. 40′2″ AD. ♀	BAIRDI CENTERVILLE, 41′ AD. ♂?	BAIRDI PRIBILOF I. 25′5″ JUV. ♂
Condylobasal (total) length of skull	1430	1372	1524	1423	1062(?)
Atlas (fused 1–3 cervicals):					
Maximum breadth	329	292	362	341	280
Height (posterior face vertical)	303	—	339	321	270
First caudal:					
Greatest height	688	—	800	658*	427
Greatest breadth	498	—	577	511*	360
Length of centrum	287	246	338	280*	200
Ninth caudal:					
Greatest height	282	—	422	335	288
Greatest breadth	184	—	243	194	191
Length of centrum	174	168	241	194	160
Eleventh caudal, length of centrum	108	104	180	156	142
Length of scapula (maximum breadth of blade)	623	503	710	670	395
Height of scapula (glenoid crest to vertebral margin)	470	356	490	445	280
Length of humerus (maximum caliper)	318	274	—	340	248
Breadth of humerus at distal end (maximum caliper)	163	109	—	170	115
Length of radius	350	295	—	380†	220
Breadth of radius at distal end	122	84	—	140	88
Length of ulna (including olecranon)	389	323	—	—	241
Breadth of ulna at distal end	105	79	—	—	71

* second
† median

that one unfortunately belonged to an immature individual. The measurements are therefore not strictly comparable since the bony excrescences are enlarged with age. Old individuals have a pronounced bony excrescence on the partition behind the internal acoustic meatus. The size and shape of the posterior process is altered markedly with age. The comparative measurements are indicated on the enclosed sheet."

The periotic dimensions referred to are contained in Table 3. In general we

find ourselves in agreement with Dr. Kellogg's conclusions. Without pursuing the subject much farther in the absence of adequate comparative material, we wish to make certain additional contrasts (not presented to Dr. Kellogg) between the Ocean City specimen and earlier specimens of both *bairdi* and *arnuxi*. In Table 2 the measurements of various parts of the axial and appendicular skeletons of our specimen are presented along with similar measurements of one specimen of *arnuxi* and three of *bairdi* as contained in True (1910:75). Since attention has been drawn to the skull versus vertebral column components of the total length as a diagnostic character, the available centrum lengths have been reduced to percentages of the condylobasal lengths with the results shown in Table 4.

TABLE 3.—*Comparative measurements in millimeters of the periotic bones of two specimens of Berardius*

	RIGHT PERIOTIC ADULT, OCEAN CITY, WASHINGTON	RIGHT PERIOTIC IMMATURE, NO. 142118 USNM. BERING ISLAND
Maximum transverse diameter of periotic at level of fenestra ovalis	·35.7	34.5
Maximum length of periotic, tip of anterior process to tip of posterior process	75.8	75.0
Maximum dorso-ventral depth of periotic, from most inflated portion of tympanic face of pars cochlearis to tip of oseous projection from internal acoustic meatus	32.3	23.0
Distance between fenestra rotunda and tip of anterior process.	49.6	45.3
Distance between fenestra rotunda and tip of posterior process	37.0	42.0
Distance between epitympanic orifice of aquaeductus Fallopii and tip of anterior process	43.0	37.0
Maximum antero-posterior diameter of pars cochlearis	25.0	25.2
Transverse versus vertical diameters of internal acoustic meatus	6 x 11	7 x 12
Extremity of anterior process to anterior edge of fossa for malleus	36.4	34.0
Greatest length of posterior process	30.5	24.5

While the first caudal vertebra centrum length seems to offer little chance of proving to be a specific character, the ninth and particularly the eleventh appear to differ markedly; in each of the latter vertebrae the relationships of the Ocean City specimen are in close agreement with the specimen of *arnuxi*, and in strong contrast with the three specimens recorded as *bairdi*.

Due to the scarcity and slow accumulation of formally recorded specimens, it has been customary for occidental zoologists to consider *Berardius* a great rarity throughout its range. Direct evidence that this is not the case in Japanese waters is furnished by the reports of Kuroda (1938), Ogawa (1938), and Matsuura (1942, 1943*a* and *b*) which record that from forty to fifty Baird whales are taken annually from July to October off Shirahama in Chiba Prefecture, west central

Honshu. (See also reference in Pike, 1951, to more recent (1949 and 1950) Japan area kill.) Matsuura (1943*a*) also reports the occurrence of this beaked whale in the Sea of Okhotsk. The Japanese practice of harvesting the smaller whales, and the large number of whaling stations dotting the hundreds of miles of Japanese coastline between Shirahama and the Okhotsk Sea, clearly accounts for the killing of considerable numbers of *Berardius* each year. Unfortunately, the Japanese beaked whale kill is indistinguishable in the records of the Committee for Whaling Statistics because of the local practice of lumping all small whales under a non-specific category.

During a period of fourteen months recently spent by the junior author in northern Japan for the purpose of studying the fur seal fishery, opportunities arose to observe the kill of cetaceans at various points along the coast. Only two beaked whales were noted in this way. During a two-week stay in April, 1949, at Abashiri on the Okhotsk seacoast, two *Berardius* were hastily examined after being brought in to the station by the two small whaling vessels then operating. The head of one of these specimens is shown in Plate I. The species was well known to the whalers who stated that it was the most commonly encountered

TABLE 4.—*Centrum lengths as percentages of condylobasal lengths in Berardius*

	BERARDIUS OCEAN CITY FEMALE ? AD.	B. ARNUXI NEW ZEALAND (FLOWER)	B. BAIRDI PRIBILOF I. FEMALE AD.	B. BAIRDI CALIFORNIA MALE ? AD.	B. BAIRDI PRIBILOF I. MALE YOUNG
1st caudal vertebra	20.0	17.9	22.2	—	18.8
2nd caudal vertebra	—	—	—	19.7	—
9th caudal vertebra	12.1	12.2	15.8	13.6	15.1
11th caudal vertebra	7.5	7.6	11.8	11.0	13.4

of the three small whales taken there (*Berardius*, *Balaenoptera acutorostrata*, and *Grampus* [Orca]), but that it was alert and hard to capture. Squid and octopus were said to be the foods normally found in the stomachs of *Berardius*, but both *Berardius* and *B. acutorostrata* were occasionally found gorged with herring (*Clupea pallasi*). The name by which the whalers referred to this beaked whale was not recorded, but Matsuura (1943*a* and *b*) gives the provincial (Chiba Prefecture) name of "Tsuchimbo" and the English names of "Northern Porpoise Whale" and "Sperm Whale Porpoise".

The existence of Russian and Japanese reports of a "bottlenose" whale recorded as the Atlantic species of *Hyperoodon* has long complicated the naming of the large ziphiids taken by whalers in the northern Pacific. The question of whether *Hyperoodon* really occurs has led us to scan the available literature pertaining to the cetaceans of the waters in question. One Japanese and four Russian reports have been found which claim the presence of *Hyperoodon* (Tanaka, 1934; Arsenyev, 1937; Zenkovic, 1937; Tomilin, 1937 and 1938), although more formally documented reports by Barabash-Nikiforov (1938:328) and Japanese zoologists (e.g. Ogawa, 1938; Kuroda, 1938; and Matsuura, 1942; 1943*a* and *b*) do not record them. The latter authors represent the ziphiid fauna as consisting

of *Berardius*, *Ziphius*, and *Mesoplodon* species, whereas those which claim *Hyperoodon* list none of the others. No diagnostic illustrations are provided by the *Hyperoodon* claimants. Complete translations of these papers have not been made, but those portions which have been deciphered are either indeterminate or point definitely toward *Berardius*. The large size of specimens measured by Tomilin (1938), the females being more than equal to the males, is a case in point. Thus far all evidence points to a simple case of name-transfer from the Atlantic fishery, bolstered by the "bottlenose" whale statistics from the American coast. It seems equally clear that these publications, while not establishing the presence of *Hyperoodon*, are still of considerable value in recording facts which may be confidently transferred to the literature of *Berardius* in the northern and western parts of the North Pacific. (See also Committee for Whaling Statistics, 7:10 and 17:34–35.)

The best inference of the long-term status of *Berardius* is probably to be drawn from the currency and long-standing of the name "Bottlenose Whale" as applied by the whalers of American coastal waters, where the true bottlenose (*Hyperoodon* spp.) has never been validly reported (see above and Cowan, 1945), and where *Berardius* may therefore be considered the only beaked whale of a size likely to interest Caucasian whalers. As long ago as 1874, Scammon, writing of the early years of the whale fishery in the waters off the northwest American coast, reported the use of the name bottlenose (Bottlenosed Grampus, cf. also Square-headed Grampus) in connection with descriptive comments which, although apparently confused, clearly refer in part to ziphiids of large size. A half-century later Kellogg (1931) presented catch statistics for Pacific coast whaling stations covering the 11-year period from 1919 through 1929 in which mention is made of seven "Bottlenose" captures, six being recorded from British Columbia and one from California. Radcliffe (1933:27–33) followed with a more extensive tabulation covering the 22-year period from 1911 through 1932, in which 23 bottlenose landings were recorded—fourteen in British Columbia, eight in Washington, and one in Alaska. No more recent captures are indicated for this coast in the tabulations of the Committee for Whaling Statistics (1930–50), but Pike (1952) reports on numbers seen and two captured by whalers off Vancouver Island in the summers of 1950 and 1951, and a California (Eureka) capture in May of the latter year. Apparently no general assignment of the bottlenose of the American north Pacific whaling industry to any definite species has previously been made, although compilers of faunal lists (e.g. Grinnell, 1933:216; Scheffer and Slipp, 1948:266) have done so for particular sections of the coastline, in each case designating *Berardius bairdi* as the presumptive species.

LITERATURE CITED

ARSENYEV, V. A., *et al.* 1937. On the hunting and utilization of sea animals and sharks in the Far East. Bull. Pac. Sci. Inst. Fisheries and Oceanography, Vladivostok, 10: 1–115, (in 7 parts, in Russian, English summaries).

AUSTIN, O. L., *et al.* 1948. Japanese ornithology and mammalogy during World War II. Report No. 102, Natural Resources Section, General Headquarters, SCAP, Tokyo.

BARABASH-NIKIFOROV, I. 1938. Mammals of the Commander Islands and the surrounding sea. Jour. Mamm., 19: 423–429.

COMMITTEE FOR WHALING STATISTICS. 1930–1950. International Whaling Statistics (Oslo), vols. 1–24.

COWAN, I. M. 1945. A beaked whale stranded on the coast of British Columbia. Jour. Mamm., 26: 93–94.

FLOWER, W. H. 1871. On the recent ziphioid whales, with a description of the skeleton of *Berardius arnouxi*. Trans. Zool. Soc., London, 8: 203–234.

GRINNELL, J. 1933. Review of the recent mammal fauna of California. Univ. of Calif. Publ. in Zool., 40: 71–234.

KELLOGG, R. 1931. Whaling statistics for the Pacific coast of North America. Jour. Mamm., 12: 73–77.

KURODA, N. 1938. A list of the Japanese mammals. Tokyo. 122 p.

MATSUURA, Y. 1942. On the northern porpoise whale, *Berardius bairdii* Stejneger, in waters near Bosyu. Zool. Mag., Zool. Inst., Faculty of Science, Tokyo Imperial University, 54: 466–473.

———. 1943*a*. *Berardius bairdii* Stejneger ranges the Sea of Okhotsk. *ibid.*, 55: 237.

———. 1943*b*. Marine mammals (Kaiju). Tokyo. 298 p.

NORMAN, J. R., AND F. C. FRASER. 1949. Field book of giant fishes. Putnam & Sons, New York.

OGAWA, T. 1938. Studien über die Zahnwale in Japan . . . Arb. Anat. Inst. Kaiserl., Japan Univ., Sendai, 21: 173–218.

OKADA, Y. 1938. A catalog of vertebrates of Japan. Maruzen Co., Ltd., Tokyo. 412 p.

PIKE, G. C. 1952. Two records of *Berardius bairdi* whale from the coast of British Columbia. Jour. Mamm., (this issue).

RADCLIFFE, L. 1933. Economics of the whaling industry . . . *In* Report pursuant to Sen. Res. 246, . . . 73rd Congress, 2nd Sess., Senate committee print. 79 p.

SCAMMON, C. M. 1874. The marine mammals of the north-western coast of North America . . . together with an account of the American whale-fishery. J. H. Carmany and Co., San Francisco. 319 p.

SCHEFFER, V. B. 1949. Notes on three beaked whales from the Aleutian Islands. Pacific Sci. 3: 353.

SCHEFFER, V. B., AND J. W. SLIPP. 1948. The whales and dolphins of Washington State with a key to the cetaceans of the west coast of North America. Amer. Midl. Nat., 39: 257–337.

TANAKA, S. 1934. Suisan-doshoku butsu zuetsu (aquatic products of commerce). Daiichi-shoin, Tokyo. 607 p. (Japanese with index to Latin names)

TOMILIN, A. C. 1937. The whales of the Far East. Mémoires Scientifiques de l'Univ. de Moscow, 13: 119–167. (Tables, key, photos of large whales and fetuses. In Russian, summary in English)

———. 1938. La hypéroodon (Hyperoodon rostratus Pontop.) et les petits baleinoptères (Balaenopteridae) de l'Extrême-Orient. Bul. Soc. Nat. Moscow, sect. biol., n.s., 47: 210–217. (In Russian, with French resume)

TRUE, F. N. 1910. An account of the beaked whales of the family Ziphiidae. . . Bul. U. S. Nat. Mus., 73: 89p.

VAN BENEDEN, P. J., AND P. GERVAIS. 1868–1880. Osteographie des Cétacés vivants et fossiles. . . A. Bertrosed, Paris, 634 p.

ZENKOVIC, B. A. 1937. Weighing of whales. Comptes Rendum (Doklady). Acad. Sci., USSR, n.s., 16: 177–182. (In English)

School of Fisheries, University of Washington and Branch of Wildlife Research, U. S. Fish and Wildlife Service, Seattle, Washington. *Received April 1, 1952.*

GENERAL NOTES

THE TECHNICAL NAME OF THE AFRICAN MUISHOND (GENUS *ICTONYX*)

Hershkovitz (1949) holds that the African polecats currently known as *Ictonyx* should be called *Zorilla* I. Geoffroy, 1826, and that the Cape Stinkmuishond, currently known as *Ictonyx striatus* Perry, should be called *Zorilla mapurito* Müller, 1776.

Hershkovitz's claim rests on his belief that the "Zorille" of Buffon (1765) could not possibly represent any American mustelid, but clearly represents the Cape Stinkmuishond; and the fact, which we do not dispute, that *Zorilla* I. Geoffroy and *Viverra mapurita* Müller, 1776 (it is *mapurita* in the British Museum copy of Müller, not *mapurito* as quoted by Hershkovitz) were both based on the "Zorille" of Buffon (Pl. I).

But we completely disagree with Hershkovitz's diagnosis of Buffon's "Zorille", which to us clearly represents a member of the American genus *Spilogale*.

Hershkovitz says that Cuvier (in Azara, 1801) "showed that Buffon's *zorille* . . . is a native of the Cape of Good Hope and not related to any American or European mustelid". But Cuvier did not "show" anything of the sort; he merely made a bald statement: "le Zorille, dont la figure est donnée par Buffon dans la planche 41 du t.3, edit. in-4°, est un animal du Cap de Bonne-Espérance, que Buffon a mal-à-propos considerée comme propre à l'Amerique . . . c'est le *Viverra Zorilla* de Linné et la *Marte Zorille* de La Cépède." In any case, it is not clear why Cuvier, 1801, should be regarded as the last word on African and American mustelids.

Hershkovitz also quotes Howell (1906) in support of his theory, saying that Howell was inclined to identify Buffon's Zorille with the genus *Spilogale* "but prudently rejected the name for any known form of *Spilogale*". But what Howell actually said of Buffon's Zorille was: ". . . *le Zorille* was described from a specimen in the cabinet of a curate in Paris; this was doubtless the first specimen of *Spilogale* to find its way into the hands of any naturalist, and the figure with accompanying descriptions furnishes the first accurate portrayal of any species of the genus". Howell further expressed the opinion that Buffon's specimen probably came from Mexico.

Hershkovitz concludes his case by drawing attention to the white-edged ears and extensively whitened tail of "le Zorille" in Buffon's plate, and saying that these features are diagnostic of the Cape Stinkmuishond and positively eliminate from consideration all American mustelids. White-edged ears, it is true, would indicate the African animal, but they are not convincingly shown in the plate, and not mentioned in the text. As for the extensive whitening of the tail, we have specimens of *Spilogale* with as much white on the tail as is shown in Buffon's plate (Pl. I).

The important point, however, and one which Hershkovitz does not even mention, is that the pattern of stripes in *Spilogale* is quite different from that in the African polecats. In the latter there is a simple pattern of four unbroken white stripes down the back, from the head to the root of the tail. In *Spilogale*, however, the pattern is more complicated. This genus, too, has four white stripes starting from the head, but they end half-way down the back; a third pair of white stripes run from just behind the elbow back along the flank and then curl upwards and forwards, and almost (or quite) meet the ends of the median pair of dorsal stripes. In the region of the kidneys there is a pair of white spots, and over the hips a pair of white bands. There is a small white spot on each buttock, and a white mark on the dorsal surface of the root of the tail.

Both Buffon's plate of "le Zorille", and his very detailed description, quite clearly refer to a *Spilogale*, and equally clearly can not be held to represent the Cape Stinkmuishond.

The generic name *Zorilla* I. Geoffroy, 1826, and the specific name *Viverra mapurita* Müller, 1776, therefore both belong to the spotted skunks of America. *Zorilla* I. Geoffroy antedates *Spilogale* and it is realised that this may cause inconvenience. But it is submitted that the right course for those most concerned with the latter genus is not to attempt to export the inconvenience to a place where it does not belong, but to apply to the Interna-

PLATE I

(Upper) "Le Zorille" of Buffon; (Middle) skin of *Spilogale putorius*; and (Lower) skin of *Ictonyx striatus*.

tional Commission on Zoological Nomenclature to have *Zorilla* I. Geoffroy placed on the *Official Index of Rejected and Invalid Generic Names in Zoology*.

Finally the African polecats should continue (*pace* Hershkovitz) to be known as *Ictonyx* Kaup, 1835, and the Cape Stinkmuishond as *Ictonyx striatus* Perry, 1810.

LITERATURE CITED

AZARA, F. DE. 1801. Essais sur l'histoire naturelle des quadrupèdes de la province du Paraguay, 1: 239 [Translation by Moreau-Saint-Mery, from the unpublished Spanish MS., with notes by Lacepède and Cuvier].

BUFFON, G. L. L. DE. 1765. Histoire naturelle, 13: 289, 302–3, pl. 41. [Hershkovitz dates this from 1755 and says that in his copy plate 41 is misnumbered 29. The copies in the British Museum and in the library of the Linnean Society of London, which are both believed to be first editions, bear the date 1765 and have the plate correctly numbered.]

HERSHKOVITZ, P. 1949. Technical names of the African Muishond (genus *Zorilla*) and the Colombian hog-nosed skunk (genus *Conepatus*). Proc. Biol. Soc. Washington, 62: 13.

HOWELL, A. H. 1906. Revision of the skunks of the genus *Spilogale*. North Amer. Fauna, No. 26: 13.

MÜLLER, P. L. S. 1776. Des Ritters C. von Linné . . . vollständiges Natursystem nach der zwölften Lateinischen Ausgabe . . . Supplementsband: 32.

J. R. ELLERMAN AND T. C. S. MORRISON-SCOTT, *British Museum (Natural History), London, S.W. 7.* *Received July 28, 1952.*

SHREWS FROM MICHOACÁN, MÉXICO, FOUND IN BARN OWL PELLETS

A small, rocky hill rises east of Lago de Chapala, Michoacán, in a flat area formerly a lake bed, but now irrigated and in cultivation. This hill, known as Cerrito Loco, is approximately 200 feet high and is two miles east of La Palma. On the evening of May 13, 1950, Albert Alcorn was shooting bats in the area when he saw an owl flying toward the hill. The owl was shot and proved to be a female barn owl, *Tyto alba* (KU 29708), carrying in its claws a cotton rat, *Sigmodon hispidus*. The following day, Alcorn searched the area and flushed three barn owl from the bluffs of Cerrito Loco, and from below their roosts he collected 170 pellets. From the matted masses of skeletal parts and hair, Alcorn segregated 44 complete or partial skulls of shrews, which he sent to Baker for examination. Forty-one skulls are of the genus *Cryptotis* and are referred to *Cryptotis pergracilis pergracilis* (Elliot), since they are indistinguishable from the skulls of three specimens of this subspecies (KU 30822-30824) from one mile south of Ocotlán, Jalisco. This shrew has been recorded one other time in Michoacán at Colonia Ibarra, Pátzcuaro (Hall and Villa R., Univ. Kansas Publ., Mus. Nat. Hist., 1: 440, December 27, 1949). The other three skulls (KU 42586–42588) from the owl pellets are *Notiosorex crawfordi*, and on geographic grounds are referred to the subspecies *evotis* (Coues). To our knowledge this is the first record of *Notiosorex crawfordi* in Michoacán and the most southern locality from which it has been taken.—ROLLIN H. BAKER AND ALBERT A. ALCORN, *Museum of Natural History, University of Kansas, Lawrence, Kansas and Fallon, Nevada.* *Received January 10, 1952.*

MASKED SHREW, *SOREX CINEREUS*, IN UTAH

The occurrence in Utah of shrews belonging to the species *Sorex cinereus* has long been suspected. Until recently, however, there has been no indisputable evidence of their existence within the state. The earliest mention of these animals in Utah was by Barnes (Bull. Univ. Utah, 12, no. 15, April, 1922) in which he referred to them under the name *Sorex personatus*. He stated that they occurred uncommonly in the Wasatch and Uinta mountains. Barnes reiterated the same statements five years later (Bull. Univ. Utah, 17, no. 12, June, 1927), but employed the name combination *Sorex cinereus cinereus* for animals from Utah.

In neither publication did he list any specimens, and we are informed by him (*in verbis*) that he had none. Furthermore, Barnes reported that his inclusion of this species in his accounts was done at the suggestion of H. H. T. Jackson who saw his manuscript, and who was himself in the process of revising the long-tailed shrews of North America. In 1928, one year after the second paper by Barnes, the revision appeared (Jackson, N. Amer. Fauna, 51, July 24, 1928). In his distribution map, Jackson (*op. cit.*: 39) included extreme north central and northeastern Utah within the range of *S. c. cinereus*. This was a surmise on his part, because he, like Barnes, possessed no specimens of this species from Utah. For the next 20 years, the question remained unanswered. In 1949, Durrant (MS), having no specimens from Utah placed this species in his hypothetical list.

Newey (MS) reported finding the lower jaws of two shrews belonging to *S. c. cinereus* in owl pellets from Weber County. Three additional specimens from elsewhere within the state were found in the collections of the Museum of Vertebrate Zoology, University of Utah. The five now known specimens of *S. c. cinereus* from Utah are from the following localities: female, no. 5136, Head of Lambs Canyon, 9000 feet, Salt Lake County; female, no. 6674, Wildcat Ranger Station, 8000 feet, Garfield County; male, no. 7192, one-half mile south of Mount Nebo Ranger Station, 6125 feet, Juab County; nos. 7405 and 7406 (mandibular rami), Beaver Creek, South Fork, Ogden River, 6500 feet, Weber County.

The paucity of specimens and the localities of capture indicate that these animals occur sparingly throughout the mountainous areas of Utah. It is noteworthy that the localities of occurrence of these animals in Utah extend the known range of this species 250 miles southward in this region and into the eastern drainage of the Great Basin.—Stephen D. Durrant and J. Paul Newey. *Contribution of the Department of Vertebrate Zoology, University of Utah, Salt Lake City, Utah. Received January 26, 1952.*

GRAY SHREW, *NOTIOSOREX*, FROM EASTERN OKLAHOMA

On September 6, 1950, I collected an adult female gray shrew, *Notiosorex crawfordi crawfordi* (Coues), in northeastern Pushmataha County, southeastern Oklahoma. No previous record of *Notiosorex* in Oklahoma has been found, and the specimen is presumed to constitute a new mammal record for the state.

This shrew specimen was collected in the course of field work in a mesic ravine community one mile south of Nashoba. Nashoba lies in a valley of the Kiamichi range of the Ouachita Mountains. Intensive live-trapping was in progress on a steep forested slope which faces north and drains into the Black Fork of the Little River. Traps were concentrated in talus of Pennsylvanian sandstone, formed by loosely-piled boulders with many large interspaces.

The shrew had entered a trap set in the midst of talus near the summit of the ridge and had succumbed in the trap. She was pregnant and contained five embryos which averaged 9 mm. in crown-rump length. Three body measurements of the adult specimen were taken; total length, 90 mm.; tail length, 31 mm.; hind foot, 10.9 mm. The specimen was prepared as a standard museum skin, and the skin and skeleton are deposited in the Texas Natural History Collection of The University of Texas in Austin (No. 2585).

Very dark pelage and apparent cranial differences prompted me to send the specimen to Dr. H. H. T. Jackson, to whom I am indebted for an opinion on its taxonomic position. He attributes the darker color to a fresh pelage condition closely matched by specimens from Texas and New Mexico. The apparent differences in cranial proportions are probably related to the senile condition of the individual, a very old one as evidenced by greatly worn teeth.

Sealander (Jour. Mamm., 33: 105–06, 1952) has recently reported the identification of a shrew from Crawford County, Arkansas, as *Notiosorex*, so the specimen here reported does not greatly extend the known range of the gray shrew. It does suggest, however, that a relict population of *Notiosorex* persists in the relatively mesic environment of the Ozark and Ouachita mountains of Oklahoma and Arkansas. This is surprising, since its affinities are with the fauna of the Great Plains and the arid Southwest. The distinctly eastern affinities of the mammal fauna of the Nashoba, Oklahoma, locality may be demonstrated by listing the nine other species of small mammals collected there and deposited in the Texas Natural

History Collection. They are as follows: *Didelphis virginiana virginiana* Kerr, *Scalopus aquaticus pulcher* Jackson, *Lasiurus borealis borealis* (Muller), *Tamias striatus venustus* Bangs, *Peromyscus leucopus leucopus* (Rafinesque), *Peromyscus gossypinus megacephalus* (Rhoads), *Peromyscus boylei attwateri* Allen, *Neotoma floridana osagensis* Blair, and *Pitymys nemoralis* (Bailey). Only the gray shrew and the brush mouse (*Peromyscus boylei*), in this faunal association, are distinctly western species.—WILLIAM K. CLARK, *Dept. of Biology, Sam Houston State College, Houtsville, Texas. Received February 18, 1952.*

A SECOND *NOTIOSOREX* FROM OKLAHOMA

Recent notice of *Notiosorex crawfordi crawfordi* from southeastern Oklahoma (Clark, see above) and Arkansas (Scalander, Jour. Mamm., 33: 105–6, 1952) prompts me to place on record a second specimen of this rare shrew for Oklahoma. The specimen consists of an incomplete skull, including rostrum, both rami of the lower jaw, and a portion of the cranium. These parts were recovered from a barn owl pellet, collected with about thirty others in August, 1949, from a cave in Tesquite Canyon, Cimarron County, in the extreme northwest corner of the Oklahoma Panhandle. This location is approximately 125 miles northwest of the northernmost record for Texas, Hutchinson County, and 260 miles northeast of the nearest record for New Mexico, Mt. Taylor (Bailey, N. Amer. Fauna 53: 369, 1931).

The only teeth remaining in the skull are P^4, M^1, and M^2 on each side above, and M_1, M_2, and M_3 below. Originally one large lower incisor was also present, but this tooth was unaccountably lost. Its exposed portion was light orange in color. All of the remaining teeth are white, except that the paracone on each P^4 has a touch of orange on the anterior face, and there is the faintest tinge of color on the tip of the protocone of each M_1.

The skull seems to be that of a young individual. In the region of the unicuspids there are two distinct alveoli for each tooth, all three of the large alveoli being preceded by a much smaller one. These small ones must either be for the deciduous unicuspids, or for a second root of each permanent tooth. Since the literature has no mention of the unicuspids being double-rooted, and examination both of illustrations and of one actual specimen shows no indication of a second root, the former assumption is believed to be correct.

Tesequite Canyon lies in the easternmost extension of the foothills of the Rocky Mountains, in the juniper-pinon pine vegetative association. The fauna of the region is typically western. Small mammals of the area have been recently reported (Glass, Proc. Okla. Acad. Sci. 39: 26–30, 1951). Most species of small rodents, known from the area, occurred abundantly in the pellet material. In addition, 29 specimens of *Reithrodontomys* (probably *montanus griseus*), and 68 *Onychomys leucogaster* were identified from this material. Neither of these species was collected by our field party in 1949. It is also interesting to note that one specimen of *Lasiurus cinereus* and two of *Antrozous pallidus* were recovered. The single *Notiosorex* was the only insectivore in the entire collection.

Acknowledgments are due to Dr. H. H. T. Jackson for verifying our identification of this shrew. The specimen is now No. 1501 in the Oklahoma A & M College Museum of Zoology.—BRYAN P. GLASS, *Contribution No. 194, Oklahoma A & M College, Department of Zoology. Received April 11, 1952.*

NOTES ON MAINTENANCE AND BEHAVIOR OF SHREWS IN CAPTIVITY

Pearson (Jour. Mamm., 31: 351–352, 1950) and Crowcroft (Jour. Mamm., 32: 354–355, 1951) have recently recorded their observations on keeping shrews in captivity. Adapting Pearson's methods I maintained colonies of shrews (*Sorex vagrans, S. ornatus,* and *S. sinuosus*) during the spring and summer of 1950 and 1951. In conjunction with a study of differentiation in shrews seventy-five of these animals, some of which lived for six and one-half months, were maintained in captivity during the study period. My observations agree almost entirely with those of Pearson and Crowcroft; however, additional information may be pertinent.

Shrews were obtained primarily from the tidal marshes of the San Francisco Bay Region,

but some upland forms from this region were also used. They were caught in Sherman live-traps. Traps were checked at two-hour intervals since I found that shrews left in traps longer than two hours did not ordinarily survive. Captured shrews were placed immediately in a gallon jar containing a small dish of water and a dead mouse. Usually the cranium and the abdominal cavity of the mouse were cut open to expose the brain and liver, both of which are favorite shrew foods. A handful of dry grass placed in the jar served to offer concealment and to keep the shrew dry. In the laboratory shrews were kept in glass-walled cages of 10 by 22 inches. A glass partition could be placed transversely in the cage to provide two cages of 10 by 11 inches each. This smaller area was used only for temporary placement until appropriate pair combinations could be accumulated.

A variety of foods was tried, but the most successful food used was a mixture of two-thirds brains and one-third commercial dry dog food as described by Pearson. Enough food for several days was mixed and frozen. Small portions of the mixture were fed twice daily as food for shrews must be kept fresh. The brains used in the food mixture were particularly subject to spoilage. Unfrozen brains would spoil within a few hours. However, if the brain mixture was solidly frozen when placed in the cages, it would remain fresh for a full day. Accordingly, later in the study shrews were fed only once a day, in the late afternoon. Most shrews would begin to eat the mixture as soon as it began to thaw. A transitional change of food as described by Pearson was not found to be necessary.

One object of the study was an attempt to obtain interspecific crosses between these shrews. Accordingly, adult males and females of the species named were placed together in a number of "pair" combinations for periods ranging from a few hours to six months. Shrews thus kept survived well and made no attempt to kill cagemates unless food or water were inadequate. All cages were provided with leaf litter for concealment and glass vials to simulate burrows. Most shrews slept in the vials and if alarmed while feeding would retreat to them. Light exercise wheels made of window screening were introduced into several cages with the hope that adequate exercise would encourage breeding. Most shrews took to the wheels avidly although there was a wide variation of response to them. Curiously, those shrews which used the wheels most frequently often seemed no longer concerned about concealment and in addition displayed a possessiveness about the wheel's use not observed in any other activity, including feeding. Cagemates would frequently vie for use of the wheel. The victor seemed to be the one which could start it in motion first.

Should adult shrews meet in the cage, each would pull back as if startled; then one or both animals would leave for a place of concealment. Occasionally animals after pulling back initially would face each other and threaten with shrill squeaks. At this time each animal would open its mouth and cock its head to one side. Normally, the female succeeded in frightening off the male. This would seem to imply dominance by the female. However, this pattern was repeated in instances in which males were caged together, one male member being dominant. Antagonistic behavior was not noted in immature shrews. Several immature shrews (about two months old at time of capture) lived together amicably for six weeks. Two were killed and eaten in one day when food was no longer available in the cage. The remaining five were kept together for another six weeks at the end of which time all were killed and prepared as study specimens. A litter of six recently-weaned young (about four weeks old at time of capture) found in the field were caged together for a month. These sibling shrews were even more tolerant of each other than non-sibling juveniles for they displayed no antagonism toward one another and all huddled together while sleeping.

In the spring of 1951 outdoor cages of two feet by six feet and four feet by six feet were also used. Males of all three species were placed with a female in each. Other cages held the same number of males, but in each case a female of another species. The substrate was loose soil to a depth of four inches. Depth of soil was not important since shrews never showed any tendency to burrow. Flat boards, leaves, and tufts of grass were distributed over the soil. Shrews under these conditions survived well, but I had difficulty confining them. Any rough surface provided an avenue of escape. The problem was solved by lining the cages with fourteen inch strips of cellulose acetate sunken to floor level. Shrews could not obtain

a foothold on this lining and made only feeble attempts to jump up the side. The flexible acetate strips rounded out the corners, effectively eliminating this path of escape. Although no young were born in these cages, I believe the main fault lay in the difficulty of keeping animals in proper sex combination confined during the height of the breeding season. Under the captive conditions outlined above several shrews were kept alive as long as six and one-half months in the indoor cages and four months in the outdoor cages. At the end of these periods of time all animals appeared healthy, but were killed for preparation as study specimens.—Robert L. Rudd, *Museum of Vertebrate Zoology, University of California, Berkeley, California. Received January 31, 1952.*

NOTES ON THE ACTIVITY OF SHREWS ALONG THE YUKON RIVER

During the summer of 1951, while engaged in graduate field studies under the auspices of the Alaska Cooperative Wildlife Research Unit, I made a trip down the Yukon River from Dawson, Y. T., to Circle, Alaska. At every point along this stretch of the river shrews were observed to be very abundant on the river banks and gravel bars, where, exposed by the relative lack of cover and the illumination of the northern summer nights, their activities were readily observed on numerous occasions.

Two specimens collected at widely separated stations along the river have been identified by Charles O. Handley, Jr. as *Sorex obscurus obscurus* Merriam. They bear the following data: USNM 293177, orig. no. 1, Alaska, Yukon River, 12 mi. above Eagle, 27 July 1951, skin and skeleton; USNM 293178, no orig. no. Alaska, Yukon River, opposite mouth of Charlie Creek, 19 August 1951, skin and skeleton. While the rather specialized habitat and similarity of behavior in all the individuals observed seem to indicate that only one species is involved, it should be pointed out that some of these shrews could possibly belong to any one of the following species: *Sorex cinereus, Sorex tundrensis*, or *Microsorex hoyi; S. cinereus* being the most likely possibility, according to Handley.

No systematic census or estimate was made of the numbers of these shrews, and their abundance is only known from the frequency with which they were observed each evening about my camps, scurrying here and there among the rocks and drift-wood at the edge of the river, or making long dashes over open areas of the beach. I can say, however, that in half an hour's time I could walk along the river and easily catch with my hands, as I did on several occasions, ten to a dozen of these little animals. In as much as I have no comparative data on the abundance of shrews in this region for other years, I cannot say definitely that the numbers encountered in the summer of 1951 represent a peak or near peak population, although this is certainly indicated. They were abundant to the extent of being preyed upon by a variety of avian predators. I have positive evidence from crops and pellets that they were being fed on by short-billed gulls, *Larus canus*, peregrine falcons, *Falco peregrinus*, and merlins, *Falco columbarius*, and indirect evidence for ravens, *Corvus corax*, and jays, *Perisoreus canadensis*, as these two corvids were frequently seen haunting the drift-wood debris where these shrews were particularly common.

Apparently the shrews were being attracted to the ecotone formed between the river and the forest because of the disposition of certain kinds of insects, principally of the orders Diptera, Lepidoptera, and Odonata, to alight at or near the river's edge on the moist surface of the silt banks or on damp rocks and drift-wood. Shrews were often seen in pursuit of these insects. Their hunting technique appeared to consist chiefly in dashing about at random until they literally collided with a motionless insect, which is immediately seized upon with great frenzy. There was nothing in their behavior to indicate any sort of stalking or cautious and deliberate approach toward a specific prey objective. One shrew was seen to capture a large dragon fly from a rock at the river's edge. The dragon fly set up a great commotion by beating its wings, and the two animals fell off the rock, rolling over each other on the ground, the shrew maintaining its hold all the while. They continued struggling on the ground for several seconds before the dragon fly finally succumbed to the shrew's attack, after which it was eaten on the spot. The wings were not consumed. This leads me to suspect that the

frequent occurrence of detached insect wings and elytra along the river bank is due largely to the depredation of shrews.

In addition to this concentration of living insects along the beach, a large number of dead insects is washed ashore and, with other small debris, forms little drifts a few inches beyond the water-line, and these may also be attractive to shrews, for they were often seen foraging about the water's edge, running through the water ripples and roughly following a course parallel to this drift-line, sometimes for fifty-feet or more, though I never saw one stop to take a dead insect.

Of particular interest was the readiness with which these shrews enter the water when caught between the river and a pursuer. On a number of occasions when I chased one to the river's edge, it entered the water unhesitatingly and swam quite easily out from the bank, usually following along the shore a few feet away until it tired and turned back to land. One, however, that I particularly noted on the night of July 27, at a site where they were extremely numerous, continued swimming out into the middle of the river, alternately stroking and resting, where it was finally taken up by the current and carried off diagonally down stream. It seems quite possible under ordinary conditions that one of these shrews might swim all the way across the river.—Tom Cade, *406a Palm Drive, Glendale, California. Received January 23, 1952.*

THE MERRIAM SHREW IN WASHINGTON STATE

G. G. Cantwell, in 1919, collected a specimen of *Sorex merriami merriami* on top of a bunch grass hill near Starbuck, Columbia County, Washington, at an altitude of 645 feet. It was found near the entrance of an old badger burrow, and, unfortunately, the skull was in bad condition. No other specimens were on record from Washington until, on July 2, 1951, while trapping in the sagebrush country 18 miles south of Wilbur, Lincoln County, I caught a male *Sorex merriami merriami*. It was trapped coming out of the burrow of *Lagurus curtatus pauperrimus*. Three weeks later, July 22, 1951, seventeen miles east of Ellenbsurg, Kittitas County, Washington, I caught a second specimen of *merriami*.

It is interesting to note that these two new localities are on opposite sides of the Columbia River, and are more than 100 miles apart. Further, Lincoln County is isolated from Columbia County by the Snake River, and Kittitas County is isolated from both Lincoln and Columbia Counties by the Columbia River.

In the male, hip glands (scent glands) measure approximately one-fourth inch long and one-eighth inch wide. There is no hair covering the glands, and they appear as naked spots.

Measurements of the adult male are: total length, 91.5 mm.; tail, 39 mm.; hind foot, 11 mm.; ear from crown, 5 mm.; weight in grams, 6.0. Adult female: total length, 89 mm.; tail, 33 mm.; hind foot, 11 mm.; ear from crown, 5 mm.; weight in grams, 5.9.—William B. James, *Walla Walla College, College Place, Washington. Received February 25, 1952.*

HOARY BAT SKULL IN AN INDIANA CAVE

While banding bats in Hamer Cave, Mitchell, Indiana, November 24, 1951, I picked up a number of bat skulls from the floor of the cave. Among those preserved were a skull of *Lasiurus cinereus* and one of *Lasiurus borealis borealis*. Charles O. Handley, Jr., of the United States National Museum, has verified the identification of both.

Although the occurrence of *borealis* in caves has been noted by various writers, *cinereus* apparently rarely utilizes them. Hahn reported the finding of "two partial skulls and skeletons" of *cinereus* in Donaldson Cave, Mitchell, Indiana (Proc. Ind. Acad. Sci., 1906 (1907): 142). This is the only other reference of which I am aware.—Russell E. Mumford, *Route 1, Cortland, Indiana. Received January 24, 1952.*

STATUS OF *NYCTICEIUS HUMERALIS* IN INDIANA

Only two published records of this bat appear in the literature. Lyon (Amer. Midl. Nat., 17: 1-384, 1936) knew of no Indiana record and the first specimen was taken by Clinton H.

Conoway, in Dearborn County, May 2, 1942 (Kirkpatrick, Amer. Midl. Nat., 29: 797, 1943). A female was taken in Tippecanoe County on May 23, 1947 (Kirkpatrick and Conoway, Amer. Midl. Nat., 39: 128–136, 1948). Eight new specimens are recorded here. Five of these are from Tippecanoe County, from 1947 to 1951.

In July, 1949, the writer was attracted by a stream of bats emerging each evening from a house in Brazil, Clay County, Indiana. On the evening of July 15, a butterfly net was fastened on the end of a long, cane pole enabling him to capture about a dozen bats as they left their roost. Through an error in identification, only two *Nycticeius* (both males) were preserved, although at least six were captured. These skins were subsequently given to the Joseph Moore Museum, Earlham College, where James B. Cope, Curator, realized upon cleaning the skulls that they were the species under consideration. William J. Hamilton, Jr. has confirmed this identification. The same evening that these were taken, about six *Eptesicus* were also taken in the net. Over one hundred bats emerged, but it is impossible to say how many were *Nycticeius*. It would appear that a colony was utilizing the attic with the *Eptesicus*.

Another Brazil record was established on the evening of May 8, 1951, when the writer shot a female as she emerged from another house very near the one mentioned above.

It seems quite likely that the evening bat is more common in the state than previously suspected. Also, since the three localities from which it has been recorded are widely separated, it probably occurs over the entire state. It has been reported from all of the states surrounding Indiana.—Russell E. Mumford, *Route, 1 Cortland, Indiana. Received February 8, 1952.*

MYOTIS THYSANODES THYSANODES IN IDAHO

Recently, while examining bats in the collection of the University of Kansas Museum of Natural History, a specimen of *Myotis thysanodes thysanodes* Miller from Idaho was discovered. This species has not previously been reported from this state. The specimen, a male (KU 18717), was taken at Karney Lake, Boise County, on May 22, 1944, by M. Dale Arvey. Measurements recorded by Arvey were as follows: total length, 87; tail vertebrae, 34; hind foot, 9. Measurements taken by us from the dried skin were: ear from notch, 15; tragus, 8; forearm, 44. The cranium of the bat is missing; however, a conspicuous fringe of hairs on the free border of the uropatagium and the length of the forearm leave no doubt as to its identity.

The nearest previously reported records of *M. thysanodes* are those of Dalquest (Mammals of Washington, Univ. Kansas Publ. Mus. Nat. Hist., 2: 154, April 9, 1948) from Dayton [Columbia County] and Anatone [Asotin County], Washington, and those of Roest (Jour. Mamm., 32: 346, August 23, 1951) from Josephine and Tillamook counties, Oregon.— J. Knox Jones, Jr., and Olin L. Webb, *Museum of Natural History, Lawrence, Kansas. Received March 7, 1952.*

A HOMING RECORD IN THE BAT, *MYOTIS LUCIFUGUS LUCIFUGUS*

The low percentage of recoveries from banded bats makes information on homing difficult to obtain. In one experiment, two bats from a total of 77 were recovered after being released at a distance of 228 air miles. After being collected in an attic near Wilmington, Ohio, the 42 females and 35 males were banded and released in an old barn beyond Jamestown, Pennsylvania. Both bats recovered were young, but postpartum, females collected at the end of the lactation period when the mammary glands had begun to regress. One weighed 7.5 grams and showed no tooth wear; the other weighed 6.9 grams and had very slight wear on the canine teeth. The former was recovered one year after banding and the latter after two years.—Elizabeth Smith and Kelley Hale, *Department of Biology, Kent State University, Kent, Ohio, and Surgical Hospital, Wilmington, Ohio. Received March 14, 1952.*

SOME UNUSUAL JUVENILE RACCOON WEIGHTS

During the 1950–51 trapping season on the state portion of Horicon Marsh in Dodge County, Wisconsin, some extremely heavy and some extremely light juvenile raccoons (*Procyon lotor*) were taken by trappers.

A male trapped on November 2, weight 17 pounds 8 ounces, and a female trapped on November 6, weight 16 pounds 4 ounces, were both ear-tagged in the same litter on May 30, 1950; their estimated birth date was May 1, 1950. Both were killed one-quarter to one-half mile from where they had been tagged as pups. Two male pups killed on November 25 weighed 3 pounds 3 ounces, and 3 pounds 15 ounces. They were both captured by hand with a lactating female. Three more pups about the same size escaped during the chase. On December 1, 1950, a male raccoon weighing 7 pounds 15 ounces was trapped. Its upper canine was just erupting. On December 22, a male weighing 7 pounds 6 ounces was killed in a trap three miles from the previous male. Also on December 22, two males weighing 6 pounds, and 5 pounds 12 ounces and one female weighing 5 pounds 14 ounces, were found denned together in one muskrat house where they were killed by the trapper.

It seems likely that the above data represents five distinct litters. Since only 17 juvenile raccoons were killed during the entire trapping season, it appeared that a sizable percentage of the juvenile population was late-born. For comparison, the smallest juvenile taken during the 1949–50 trapping season from a similar sized sample of juveniles weighed 8 pounds 14 ounces.

Both of the heavy juveniles were from a litter that had been ear-tagged in a wood duck box in the center of the marsh. The abundance of crippled ducks during the 1950 waterfowl season may account for their large weights since both raccoons were carrying heavy deposits of fat.

Whether the cold spring weather in 1950 decreased raccoon mobility and thus decreased the normal amount of early conception is unknown. If such was the case, late litter production should have been widespread along much of the northern edge of the range of the raccoon in the lake states. Since the survival of small raccoon pups in the severe winter of 1950–51 must have been very low, it is possible that widespread late breeding could lead to a noticeable reduction in the raccoon population. It also seems theoretically possible that the northern limit of the range of the raccoon might be determined at least in part by a high incidence of late breeding similar to that observed on Horicon Marsh in 1950.—Robert S. Dorney, *Wisconsin Conservation Department (P. R. 15R), Horicon, Wisconsin.* *Received January 23, 1952.*

PARASITES OF RACCOONS IN SOUTHWEST WASHINGTON

Between July 13 and September 28, 1946, 29 raccoons, *Procyon lotor psora*, were collected on the Willapa Harbor National Wildlife Refuge, Pacific County, Washington. The entire digestive tracts of these animals were preserved in formalin by Maurice L. Hinshaw of the United States Fish and Wildlife Service and sent to the State College of Washington for analysis. Scheffer (Jour. Mamm., 31: 444–48, 1950) reported the weights and measurements for 127 raccoons, including the ones cited above. Tyson (Jour. Mamm., 31: 448–49, 1950) examined the stomachs of the 29 raccoons in this series and reported that the contents consisted largely of marine invertebrates.

The intestinal tracts were removed from formalin in which they were stored, slit lengthwise and placed in a one-gallon jar filled with tap water. After shaking for three minutes the digestive tract was removed and examined under a dissecting microscope for parasites. The contents in the jar were allowed to settle and the sediment carefully examined with a dissecting microscope. The parasites were placed in 70 per cent alcohol and selected typical specimens were stained and mounted for identification.

Nine of the raccoons were immature animals, and of these six were infected. One had 115 *Arthrocephalus lotoris* and 5 *Brachylaemus pellucidum* in the intestine, indicating the intensity of the infection. Four others had *A. lotoris* in the intestines, and one had *Porracaecum decifens* in the stomach.

Twenty of the raccoons were mature individuals; 19 of these were infected with one or more species of helminth parasites. In the entire series, immatures and adults, the following parasites were found: *Arthrocephalus lotoris* was by far the most prevalent parasite in the series, occurring in 24 of the 29 raccoons examined. It varied from as few as 7 to as many as 2091 specimens in a single host. *Porracaecum decifens* parasitized 14 of the 29 raccoons ex-

amined and in general only one or two specimens were found in any one host. *Brachylaemus pellucidum* parasitized 9 of the 29 animals examined and varied in numbers from a single specimen to as many as 107 per host. *Ascaris columnaris* occurred in only one raccoon and a single specimen was recovered from this host. *Echinorhynchus gadi* occurred in four raccoons, one immature and three mature hosts. This acanthocephalan parasite was not attached to the lining of the digestive tract. It seems very likely that the raccoon ate fish that were infected with this parasite and the hosts were collected before the parasite was digested. Apparently *Echinorhynchus gadi* is not a parasite of the raccoon.

The authors wish to acknowledge the assistance given in the identification of "*Arthrocephalus lotoris*, *Porracaecum decifens*, *Ascaris columnaris*, and *Brachylaemus pellucidum* by J. C. Lucker, A. McIntosh, and E. E. Wehr of the Zoological Division, Bureau of Animal Industries, United States Department of Agriculture, and of *Echinorhynchus gadi* by H. J. Van Cleave, Department of Zoology, University of Illinois. This investigation was supported in part by the State College of Washington Research Fund.—CHARLES W. MCNEIL AND JOANNA T. KROGSDALE, *Department of Zoology, State College of Washington, Pullman, Washington.* *Received January 14, 1952.*

ADDITIONAL RECORDS OF THE SPOTTED SKUNK IN SOUTH DAKOTA

Recently additional specimens of the Spotted Skunk (*Spilogale interrupta*) from South Dakota have come to light which seem to merit recording.

When Arthur H. Howell (N. Amer. Fauna, no. 26, 1906) revised the genus *Spilogale* he listed only one specimen taken in South Dakota. It was collected at Sioux Falls in the southeastern part of the state, and identified as *Spilogale interrupta*. This is in the Biological Surveys Collection. Under a footnote Howell (*loc. cit.* 7) stated, "He [Merritt Cary] also reports that several spotted skunks were killed in the Black Hills, near Elk Mountain, South Dakota, in 1902 or 1903." However there was no indication of which species they belonged to and these records were not included in Howell's distribution map of *Spilogale* (*loc. cit.*, Plate I). It is of interest that a card in the Fish and Wildlife Service mammal distribution file in Howell's handwriting lists the record under *Spilogale tenuis*?.

A review of the literature indicates the paucity of exact knowledge of the distribution of this skunk in the northern plains section of its range. South Dakota was not mentioned as within the range of species of any spotted skunk by Gerrit S. Miller, Jr. (U.S. Nat. Mus., Bull. 128: 133, 1924), who apparently overlooked Howell's record mentioned above. H. E. Anthony (Field book of North American Mammals, N. Y.-London. G. P. Putnam's Sons. p. 121, 1928) includes the southeastern tip of South Dakota in the range of *interrupta*, probably on the basis of Howell's record.

Additional *Spilogale* records from South Dakota are listed in the Fish and Wildlife Service mammal distribution file as follows: M. M. Karlen, Predatory Animal Hunter, reported he had taken one male and one female in November, 1925, in Lower Brule. C. R. Young, Refuge Manager, La Creek Refuge, Bennett County, recorded approximately 50 spotted skunks on the refuge in December, 1936. Louis Knowles, District Agent of Predator Rodent Control, U. S. Fish and Wildlife Service, reported collecting a specimen at Fort Thompson, Buffalo County, in November, 1924. William H. Over and Edward P. Churchill (Mus. and Dept. Zool., U. of S. D., mimeog., 1941, p. 18) in their "Mammals of South Dakota," stated under *Spilogale interrupta*, "This little spotted skunk is common over the entire state." However, no specimen records are listed and one is left in doubt as to the possibility of spotted skunks from the western part of the state being referable to the Rocky Mountain form *tenuis* rather than *interrupta*.

Recently, a second *Spilogale interrupta* from South Dakota was added to the Biological Surveys Collection (No. 286403) through the co-operation of Lee W. Arnold, Refuge Manager of the Waubay National Wildlife Refuge, Waubay, northeastern South Dakota. This specimen, consisting of a well-made skin, was collected on Waubay Refuge by an unknown collector, in the late 1930's or early 1940's. It had previously been housed on the Waubay Refuge.

Mr. Arnold stated in a letter to me, dated October 23, 1951, that the spotted skunk was not considered common on the Waubay Refuge. However, the specimen definitely extends the known range of this species toward the northwest.

During October, 1951, the author corresponded with Dr. W. H. Over in reference to his statement (*loc.cit.*) on the occurrence of *Spilogale* in South Dakota. Doctor Over mentioned four mounted specimens in the University of South Dakota, Vermillion, collected "some 35 years ago." With his permission I am listing these with the catalog numbers and donors: no. J. 41, the late R. C. Davis, former druggist, Clay County; no. J. 163, O. C. Stanghar, Sioux Falls, Minnehaha County; no. J. 165, donor unknown, Clay County; no. J. 167, the late F. A. Patton, Artesian, Sanborn County. No further data is available on the above four specimens which are all from the southeastern part of the state.

Doctor Over also stated in the above correspondence: "I found a skull of this little mammal in a cave in the west slope of the Black Hills. I have seen it in Perkins County, one of the northwest counties of the state, besides while travelling over the state twenty-five and thirty years ago I recall vividly of seeing it often. Was too common to make records of its appearance."

The purpose of this paper is to put on record additional specimens of the spotted skunk which will help clarify its known distribution in the extreme northwestern part of its range, which does not appear to be very clearly indicated in the current literature.—Viola S. Schantz, *U. S. Fish and Wildlife Service, Washington 25, D. C. Received January 17, 1952.*

RETURNS ON BANDED RED AND GRAY FOXES IN NEW YORK STATE

Subsequent to the published returns (Sheldon, Jour. Wildlife Mgt., 14: 33–42, 1950) of wild foxes banded in New York State, eight additional banded foxes have been reported. Two of these were gray foxes (*Urocyon*) and six were red foxes (*Vulpes*). The data are summarized in Table 1.

Table 1.—*Movements of wild foxes in New York State*

SPECIES	NO.	SEX AND AGE	DATE BANDED	DATE RECOVERED	DISTANCE (IN MILES)	CAUSE OF DEATH
Red	219	♂ Juv.	5/11/48	2/6/49	17	Shot
Red	144	♂ Ad.	9/26/47	2/?/50	11	Trapped
Red	236	♀ Juv.	5/17/48	3/?/50	5	Shot
Red	119	♀ Juv.	10/20/48	5/20/49	½	Shot
Red	231	♀ Ad.	11/25/48	12/?/49	1½	Trapped
Red	246	♀ Ad.	6/7/48	2/15/50	2	Trapped
Gray	113	♀ Juv.	10/15/47	11/21/47	11	Trapped
Gray	73	♀ Juv.	10/20/47	2/?/50	52	Trapped

As in previous returns on red foxes, the males tended to roam and the females appeared to establish a more restricted "home range." Number 119 was judged to be a juvenile when captured in October, 1947, but a determination of age of red foxes at this time of year is problematical. It is of interest that this vixen was shot the following spring at a den one-half mile from its capture site; she was raising a litter of pups. Number 236 was shot in a barn and may well have had rabies although no diagnosis was made.

The returns on the two gray fox vixen pups demonstrate that the young of either sex in this species may disperse widely. Number 73, banded October 20, 1947, was trapped in Pennsylvania, 52 miles south of its original capture site in February, 1951, the longest distance traveled by any of the banded foxes of either species. This vixen was large, fat, and in excellent condition when captured.

The original banding work on which these results are based was supported by a grant from the New York State Conservation Council.—William G. Sheldon, *Massachusetts Cooperative Wildlife Research Unit (University of Massachusetts, Massachusetts Department*

of Conservation, Wildlife Management Institute, and Fish and Wildlife Service Cooperating), Amherst, Mass. Received March 3, 1952.

EARLY RECORDS OF THE RED AND THE GRAY FOX IN ONTARIO

The apparent absence of native red foxes from the eastern coastal area in the United States prior to its known introduction (Gilmore, 1946, 1949) has prompted the writers to re-examine a collection of archaeological bone fragments available to us. "There is strong evidence that the native American red fox did not range in to the middle eastern United States from the north in aboriginal times, and that the present red fox of the central eastern states is a direct descendant of the European red fox (*Vulpes vulpes*) which was introduced between 1650 and 1750 from England for fox hunting" (Gilmore, 1946: 232).

The material examined consisted of a collection of well over 10,000 fragments of bone from the famous Ste. Marie I site of the French Jesuits, located at the southeast end of Georgian Bay, near Midland, Ontario. The history of this site as well as its recent excavation by archaeologists are well documented by Kidd (1949). Begun in 1639, this mission lasted only a decade. In 1649 it was abandoned and burned by the Jesuits.

In the examination of the midden remains from this site, the writers concerned themselves only with the segregation of fox bones, both red (*Vulpes*) and gray (*Urocyon*). The bone fragments had been segregated according to moundsite and level of depth. Five levels were used, the first being the top with earlier levels deeper. Although these five levels supposedly represented a span of only a decade, the relative locations of gray and red fox bones represent an interesting relationship if not the results of pure chance.

The identifiable fox remains were as follows: Level 1, none; Level 2, gray fox, 1 lower jaw; Level 3, gray fox, 1 atlas and 1 fragment of lower jaw; Level 4, gray fox, 4 diagnostic fragments, fox (sp.?), 2 fragments, red fox, 1 femur; Level 5, red fox, 1 lower jaw.

The fact that the red fox remains were restricted to the lower levels may not necessarily indicate that the red fox occurred prior to the gray, or that it later disappeared. It does, however, suggest that its occurrence was at least as early as the abandonment of the mission in 1649 and therefore present prior to 1650, the earliest date mentioned by Gilmore for the possible introduction of the European red fox on the Atlantic coast.

The red fox has been reported in earlier archaeological sites (Wintemberg 1921, 1928, 1939 and others). Although we have been unable to verify the identity of specimens previously reported from Ontario, there seems little doubt that a native red fox did occur in southern Ontario prior to white man's first visit.

The early occurrence of gray fox in Ontario has been documented by Wintemberg (*op. cit.*) and Downing (1946) the latter giving an account of the apparent disappearance of this species and its re-occurrence almost 300 years later. Since Downing's account, the Royal Ontario Museum of Zoology and Palaeontology has received six additional specimens. Two are of *Urocyon cinereoargenteus borealis* from Leeds County (R.O.M.Z.P. No. 18801 in 1948, and No. 21579 in 1952). Concerning this general area a news release from the office of the District Forester, Department of Lands and Forests, in Kemptville, Ontario, dated January 28, 1952, contains the following: "It may be of interest to know that the gray fox is a fairly common visitor to this District. Since we have reports of litters being raised, it may be considered that this animal is a resident. One or two gray foxes are shot every year in the southern parts of Leeds, Grenville, Stormont, Dundas and Glengarry counties. They are known locally as the 'scrub fox'."

From the eastern Lake Erie region four specimens, which are tentatively referred to *U. c. cinereoargenteus*, have been received (one from Lincoln Co., R.O.M.Z.P. No. 19592, in 1949; and three from Welland Co., No. 19494 in 1948, No. 21489 and No. 21491 in 1952). An additional animal was taken in Welland County in 1948 and sent to the Museum for identification. After examining and photographing this specimen, it was returned to the collector.

The above possibly represent the first modern specimens of the latter race for Ontario. Anderson (1947) extends *U. c. cinereoargenteus* into Ontario on the basis of archaeological

specimens reported by Wintemberg (1921) from Oxford County; the unconfirmed record of Seton (1925; see Downing, 1946) and sight records reported about 1942. Further studies are needed to definitely determine the racial identity of the animals of this area.

At the present time three populations of the gray fox are apparently extending their ranges into Ontario: *U. c. borealis* around the east end of Lake Ontario, *U. c. ocythous* in the Rainy River region west of Lake Superior, and a third population, probably *U. c. cinereoargenteus*, around the east end of Lake Erie.

LITERATURE CITED

Anderson, R. M. 1947. Catalogue of Canadian recent mammals. Nat. Mus. Can. Bul. 102, Biol. Ser. No. 31, 238 p.

Downing, S. C. 1946. The history of the gray fox in Ontario. Can. Field-Nat., 60: 45–46.

Gilmore, R. M. 1946. Mammals in archaeological collections from southwestern Pennsylvania. Jour. Mamm., 27: 227–235.

——— 1949. The identification and value of mammal bones from archaeological excavations. Jour. Mamm., 30: 163–169.

Kidd, K. E. 1949. The excavation of Ste. Marie I. Univ. Toronto Press, 191 p.

Seton, E. T. 1925. Lives of game animals. Doubleday, Doran and Co., Garden City, N. Y., Vol. 1, 640 p.

Wintemberg, W. J. 1921. Archaeological evidence concerning the presence of the gray fox (*Urocyon sp.*) in Ontario. Can. Field-Nat., 35: 19–20.

——— 1928. Uren prehistoric village site, Oxford County, Ontario. Nat. Mus. Can. Bul. 51, Anthropological Ser. No. 10, 97 p.

——— 1939. Lawson prehistoric village site, Middlesex County, Ontario. Nat. Mus. Can. Bul. 94, Anthropological Ser. No. 25, 104 p.

R. L. Peterson, R. O. Standfield, E. H. McEwen, and A. C. Brooks, *Royal Ontario Museum of Zoology and Palaeontology; Department of Zoology, The University of Western Ontario; Dominion Wildlife Service, Aklavik, Northwest Territories; and Tanganyika Game Department, Arusha, Tanganyika.* *Received March 12, 1952.*

COYOTE PREDATION ON SAGE GROUSE

Although coyote predation on sage grouse is a matter of general knowledge, there are surprisingly few specific instances cited in literature. Hence, it appears worthwhile to record here an observation made in Jackson County, Colorado.

On May 24, 1951, the junior author and Albert Pierson, Government Hunter, were hunting coyote dens west of Walden when a coyote track was picked up on the flats south of California Draw. Signs along the track indicated that the animal had killed three adult sage grouse and destroyed one grouse nest. The coyote was tracked about 5 miles to a den. Approaching darkness made it advisable to plug the hole for the night, but upon examination next morning it proved to be unoccupied—merely a freshly cleaned hole into which pups could be moved if necessary. The occupied den was found about three-quarters of a mile from the clean-out. From it an old bitch and seven good-sized pups were taken. Examination of the bitch's stomach contents showed the whole heart and liver and some flesh of an adult sage hen, as well as six young sage chickens swallowed whole, apparently just before or after hatching.

The area around the den was littered with sage hen bones and feathers. Remains of no other birds or animals could be found nearby, and all indications were that the pups had been raised largely upon sage hens.—Clifford C. Presnall and Alvin Wood, *Fish and Wildlife Service, Washington, D. C. and Craig, Colorado.* *Received February 11, 1952.*

A NOTE CONCERNING WOLVES IN GLACIER NATIONAL PARK, MONTANA

During the past few winters wolves have appeared in Glacier National Park, after apparently being absent for many years. Before the disappearance of the buffalo (about 1880),

wolves were common in the region, and were still present in reduced numbers after the turn of the century. Bailey (Wild Animals of Glacier National Park, U. S. Dept. Interior: 82, 1918) mentions two which were caught on Flat Top Mountain (the present East Flattop) in the winter of 1916–17, and mentions signs containing cattle hair along the trails in Belly River valley. At that time they had been reported from the edge of the plains near Chief Mountain for the previous twenty years, and in 1914 tracks had been seen on St. Mary Ridge at the Park line; some were also said to exist in the valley of the North Fork of the Flathead River. Bailey further states that "in 1895 they seemed to be no more numerous than at the present time, as I saw then only a few tracks on the prairie below St. Mary Lake, and some fine skins among the Indians on the Blackfeet Reservation". Though they may have existed in the area around the Park subsequent to 1918, especially on the plains to the east, no records are available to me. Cowan (Canadian Jour. Research (D), 25: 141, 145, 1947) states that heavy wolf depredation against stock in the region east of Waterton Lakes National Park, Alberta, in 1921, led to their extirpation by a professional "wolfer" the following year.

In 1943 wolves were noticed by rangers in the Park in the valley of the North Fork of the Flathead River, and have been seen every year since. Records are as follows: In December, 1943, along the North Fork near Quartz Creek, a dark gray individual was seen, and two sets of tracks were observed two miles south of Logging Ranger Station near lower Camas Creek. In January, 1944, a dark gray wolf was seen at Big Prairie, and four-day-old sign was found three miles up Bowman Creek from the North Fork Truck Trail. In February tracks were also seen at the mouth of Quartz Creek and near Logging Ranger Station. Tracks were seen in November and December, 1944, along the west shore of Waterton Lake near Goathaunt Ranger Station. In the winter of 1943–44 a black wolf was seen along the eastern side of Waterton Lakes Park, and in 1944–45 two black wolves were seen. One of these, a male, was shot within the park at a grizzly-killed carcass (Cowan, *loc. cit.*, pp. 141, 145). During January, 1945, a melanistic individual was observed several times by Great Northern Railway personnel near Blacktail on the South Fork of the Flathead River. A wolf-killed deer was found on the west shore of Lake McDonald in March, 1947, and sign was later seen along the east shore; in February and March tracks were seen at Dutch, Anaconda, and Logging creeks. In June a large black wolf, followed about 100 feet behind by a mature coyote, was reported seen on Anaconda Hill; when rangers came between them, the coyote swung in a wide circle, and ran to catch up. Between December, 1947, and March, 1948, tracks and sign were found at Anaconda, Bowman, and Logging creeks. In August, 1948, tracks were in evidence near the Flathead Ranger Station (Middle Fork), and in February, 1949, tracks were seen in the Two Medicine area. During the winter of 1949–50 a wolf was seen chasing an elk near Lubec Ranger Station (Forest Service) just outside the southern border of the Park.

On May 27, 1950, a female black wolf was killed on private land, within the park boundaries about 10 miles north of Polebridge on the North Fork, after trying to run down a calf. Attempts to drive away the wolf (in the company of three others) with a jeep failed, and a ranger was called. After he, too, was unsuccessful, the most persistent animal was shot; the others, all black, and one of which was larger than that killed, left at once. The animal shot was in poor condition, thin, mangy, and apparently old. By the time it reached a taxidermist, decay was already beginning to occur. According to the taxidermist, the viscera showed evidence of the animal having been poisoned. The skull was inadvertently retained within the mounted head. A few measurements had been previously taken, (two days after the killing): weight, 130 lbs.; height at shoulders, 34 in.; length from tip of nose to tip of tail, 70 in.; tail, 22 in.; head, 13 in.; between ears, 7 in.; toenail to heelpad of front paw, 6 in.; girth of chest, 34 in.

In the winter of 1950–51, an article, carried by national wire services, reported that a wolf had been seen by the caretaker of the Many Glacier Hotel in close company with the local flock of mountain sheep. This unauthenticated report did not originate with Park authorities, but was given by the caretaker to a nearby newspaper. Park authorities are of

the opinion that this animal could have been "Jimmy", a semi-tame coyote, which has been seen near the sheep several times in the winter. During the summer this animal has been repeatedly observed by the author to approach within a few yards of ewes and their lambs, which leisurely climbed to low ledges or moved slowly away. The coyote, an accomplished scavenger and "pan-handler", never exhibited threatening behavior toward them.

The annual park game census report completed Sept. 27, 1951, covering the winter of 1950–51, reported five wolves seen, and estimated eight to be present. Two were seen at Quartz Creek, one at Hidden Meadow Ranch (between Polebridge and Quartz Creek), and one at Many Glacier (not the report of the wolf among the sheep) during the winter. One was seen during the summer of 1951 along the shore of St. Mary Lake. Tracks were seen during the winter in the Ford Creek-Kintla Lake area (a large and a small individual), at Logging Creek, at Lubec Ranger Station by the Forest Service, and in the Camas Creek-Anaconda Creek area, where a print of 4½ x 5 inches and a stride of 33 inches were measured.

Two black wolves were killed in recent years in Montana adjacent to Glacier Park, one at Swan Lake in March, 1942, the other at Polebridge, on the North Fork, in the fall of 1939. This latter specimen measured 8 feet from the tip of the snouth to the tip of the tail, was 36 inches high at the shoulders, and its weight was estimated at 140–150 lbs.

Goldman (*in* Young and Goldman, Wolves of North America, Amer. Wildlife Inst.: 447, 1944) states that "a few wolves may still persist in the mountainous region between southwestern Alberta and southeastern British Columbia". He shows Montana and northern Idaho as being within the range of *Canis lupus irremotus* Goldman, the Northern Rocky Mountain wolf, but indicates that wolves were extinct in that area at the time of his writing. He lists museum material referable to *irremotus* from Calgary, Gleichen and Lethbridge, Alberta, Priest River, Idaho, and Three Forks, Montana, as well as from numerous localities in southwestern Montana, northern Wyoming, and throughout Idaho (*loc. cit.*: 448, 449).

Cowan refers the present wolf populations of Banff, Jasper, and Waterton Lakes National Parks, Alberta, to *Canis lupus occidentalis* Richardson, the Mackenzie Valley wolf. He also refers the Three Forks, Montana, skull (on the basis of measurements given by Goldman (p. 446) to *occidentalis*. Cowan believes that the native wolves of the Banff and Jasper areas of Alberta are *occidentalis* (Goldman, *loc. cit.*: 427, mentions material from Edmonton and Smith's Landing referable to this subspecies), while those of Waterton Lakes and the adjacent area of Montana were originally *irremotus*, but that *occidentalis* has moved south in the past few years to fill the void left by the extinction or near-extinction of *irremotus* over the northern part of its range. In this connection, Young (*in* Young and Goldman, *loc. cit.*: 56) remarks that "this wolf (the Three Forks animal) is believed to have drifted into this part of Montana from southern Canada". The skull of the wolf killed in Waterton Lakes National Park in 1944 was examined by Cowan, who identified the animal as *occidentalis*. The large percentage of black wolves observed in Glacier National Park lends support to the idea that they are *occidentalis*, as this subspecies shows a high rate of melanistic individuals, while *irremotus* does not. The fact that these wolves appear mostly during the winter suggests that their origin is Canada.

The author wishes to thank Park Naturalist M. E. Beatty and Assistant Park Naturalist D. H. Robinson, of Glacier National Park, Professor I. McT. Cowan, of the University of British Columbia, and Dr. Philip Wright, of the University of Montana, for pertinent information and for examining the manuscript.—MARTIN R. BRITTAN, *Department of Zoology, San Diego State College, San Diego, California.* *Received March 1, 1952.*

BOBCAT PREYING ON PORCUPINE?

Mr. G. Whitefield, Wildlife Management Officer, reported the following to me: "On February 13th, 1952, I was called by a woman who reported to have killed a bobcat in her backyard in the outskirts of Port Arthur between 9 and 10 A.M. on the same day. She noticed the animal first sitting against the basement window. When she approached it, the animal did not try to run away. The bobcat was killed by hitting it on the body with a stick. When

checking the carcass, I noticed that about six porcupine quills had lodged in the head and from fifteen to twenty on the right flank. Two quills had pierced the one, and one quill the other, eye. Two quills had penetrated the palate. The bobcat was small, and when skinned, showed no fat." The bobcat specimen was also examined by Mr. R. Boultbee, District Forester. An unsuccessful attempt of predation by a bobcat on a porcupine seems to be indicated in this instance.—A. DE VOS, *Dept. of Lands and Forests, Maple, Ontario. Received March 3, 1952.*

PEROMYSCUS MANICULATUS BAIRDI IN KENTUCKY

Hamilton (The Mammals of Eastern United States, p. 270, 1943) gives the average measurements of 10 adults of *Peromyscus maniculatus bairdi* (Hoy and Kennicott) from "Michigan, Indiana, Illinois, and Kentucky," but does not include Kentucky in his range map, nor does he give any localities in the state. In view of the fact that his is apparently the first published record of this race in Kentucky, we consider it advisable to record our observations on this form.

On April 2, 1951, we took three specimens from Harrison County, some one and one-half miles west of U. S. 27, near Silas Creek. Two were taken from runways along a grassy fence row between two pastures, the third from a well-worn runway through a patch of chickory (*Cichorium intybus*) in a pasture.

On January 14, 1952, at about nine o'clock in the evening, we discovered an individual in a sparse, low stand of henbit (*Lamium amplexicaule*) and alfalfa (*Medicago sativa*) on the University of Kentucky Farm in Fayette County. When the light from our lantern fell upon the animal, it remained motionless, and was easily picked up by hand. The pupil of each eye appeared quite opaque; apparently the animal was blind, or nearly so. However, it was quite fat, and contained three 11 mm. embryos.

On January 23, 1952, a second specimen was taken from the University farm. This individual was trapped from a grassy fence row and showed three distinct placental scars. On February 27, 1952, Major V. K. Dodge of Lexington brought seven specimens to us that he had taken that afternoon from his farm located in Woodford County on the Woodlake Pike some three miles west of Midway.

According to Major Dodge, eight individuals, four adults and four young, were dug from a single nest located some seven inches beneath the surface of the ground under a clump of fescue in a field of Ky. 31 Fescue (*Festuca elatior* var. *arundinacea*). The nest, consisting wholly of sheep wool, was about four inches in diameter. The adult mice included one male, two lactating females, each with four placental scars, and one pregnant female, with a single 9 mm. embryo. A dog that was responsible for the discovery of the mice in the first place devoured one of the young. The remaining three are apparently of two litters. One individual, well-furred and with eyes partially open, has the following measurements (in millimeters): total length, 80; tail, 23; hind foot, 13. The other two young are sparsely furred, the eyes tightly closed, and average: total length, 57.5; tail, 18; hind foot, 9.

Average measurements of the nine adults collected are: total length, 139.7 (128–149); tail, 55.8 (49–60); hind foot, 17.6 (17–19).—ROGER W. BARBOUR AND WILLIAM L. GAULT, *Department of Zoology, University of Kentucky, Lexington, Kentucky. Received March 15, 1952.*

PARTURITION OF A CAPTIVE MEADOW VOLE

The following observations were made on *Microtus p. pennsylvanicus* at Albany, New York, on May 27, 1951. The vole was captured on the previous day, and placed in a small wire cage about fifteen inches square during the observation period.

At 10:30 AM I noted that the mouse was giving birth. The first of the litter was born at 10:33. The mother bit off the umbilical cord, gave the young one a brief and perfunctory lick, and pushed it aside. The young was active for about one minute, but then became quiet. At 10:39 the second young was born. The same procedure was followed with this and succeeding young. The third arrived at 10:45, followed by the fourth at 10:51. At this time the

labor appeared to be intense, the body of the mother expanding and contracting rapidly. At 10:59 the fifth young was born, and for a time it appeared that this completed the litter. At 11:13, however, the sixth and last young appeared.

As soon as the last young had been delivered, the mother ate and drank before caring for her offspring. After picking up one of the young, licking it, and replacing it, she quickly covered all six with grass, which had been placed in the cage while the young were being born. She then proceeded to build a nest with the remaining grass. The nest was completed at 11:35. The mother crawled inside the nest and apparently went to sleep. She did not reappear until 1:33 PM. No movement of the young was seen after 12:45 PM, and I had presumed that they were dead, but the mother picked the young up one by one in her mouth and carried them into the nest. This operation was completed in about two minutes. The mother reappeared to drink and eat at 3:20, 4:20 (when she was alarmed by the observer and ran back into the nest, to reappear at 4:30), at 6:35, 8:25, and 11:15. Each time she returned to the nest immediately, after satisfying her hunger and thirst.

All six of the young mice survived the irregular treatment they had received. On May 30, when three days old, a change in coloration indicated the presence of fur beneath the skin. On May 31 this fur had come through, and the first squeak was heard from one of the young. On the fifth day the young hung to the nipples with such tenacity that one or two were frequently carried along when the mother came out to eat and drink.

On the seventh day, June 3, the entire body, except the belly, was covered with the fine soft juvenal fur. More grass placed in the cage at this time was promptly incorporated into the nest by the mother.—DAVID E. MANLY, *New York State College for Teachers, Albany, New York.* *Received February 22, 1952.*

A GOLDEN MANTLED SQUIRREL'S RACE FOR LIFE

On July 25, 1949, my attention was attracted by the mournful notes of an animal in distress. Upon investigating, a golden mantled squirrel (*Citellus lateralis*) was seen racing along the roadway near a small lake formed by Smokey Springs near the U Bar Ranch in Uintah Canyon, Duchesne County, Utah. It was dodging back and forth trying to lose its pursuer, a weasel (*Mustela frenata*). Although the squirrel was racing at top speed and trying all types of maneuvers, it was not able to increase the distance between the weasel and itself. Suddenly the squirrel turned and darted straight for the lake, leaping headlong into the icy waters.

The weasel, in hot pursuit, plunged into the water also, but retreated immediately to a large rock approximately three feet from shore. From this point he peered carefully about trying to locate the squirrel until he noticed the author and fled to the surrounding shrubbery.

As I was curious to know what had happened to the squirrel, I stood on the rock searching for it. It was soon located, nearly exhausted, in about six inches of water near the base of the rock. It remained motionless for about one minute then glanced furtively about and darted quickly to safety among the rocks and shrubbery near the lake.—MERLIN L. KILLPACK, *Biological Department, Union High School, Roosevelt, Utah.* *Received March 10, 1952.*

RICHARDSON GROUND SQUIRREL IN UTAH

The earliest mention of animals now referred to *Citellus richardsoni* from Utah was that by Barnes (Bull. Univ. Utah, 12: 49, 1922), for which he employed the name *Citellus elegans*. He did not list any specimens, however, and merely stated that the range in Utah was the northeastern part of the state. Durrant (Univ. Kansas Publs., Mus. Nat. Hist., 6: 1–549, 1952) in his report upon the mammals of Utah suspected that animals referable to the species *C. richardsoni* occurred there, but lacking actual specimens, he placed this species in his hypothetical list. Howell (North Amer. Fauna 56: 77, 1938) recorded specimens of *C. richardsoni elegans* from Evanston and Lonetree, Wyoming, both localities being less than ten miles from the Utah–Wyoming border.

On June 29, 1951, M. R. Lee, Jr. and I collected a specimen at Randolph, Rich County, Utah. On July 17, 1951, S. D. Durrant and I collected eight specimens at Wasatch, Summit County, Utah, and an additional eight specimens from one mile north of Randolph, Rich County, Utah. As far as I know these are the first animals from Utah of this species that have been preserved as scientific specimens. They are now in the collection of the Museum of Vertebrate Zoology, University of Utah. Perhaps additional collecting will reveal that, in Utah, animals belonging to this species occur along the northern piedmont of the Uinta Mountains and thence eastward to Colorado.

These specimens from Utah agree essentially with the description of *Citellus richardsoni elegans* as set forth by Howell (North Amer. Fauna 56: 76–77, 1938); also their localities of capture are adjacent to the range ascribed to this subspecies by Howell. Therefore, they are referred to that subspecies.

These animals from Rich and Summit counties live in greasewood and sagebrush areas, in open areas along roadsides, and along the margins of irrigated farmland and meadows. It is noteworthy that, when Richardson ground squirrels and Uinta ground squirrels (*Citellus armatus*) occurred together in the same general area, the Uinta ground squirrels occupied the wetter, more grassy habitats, while the Richardson ground squirrels occupied the drier and better drained soils, which were generally characterized by greasewood and sagebrush.

Funds for the field work were provided by a grant from the University of Utah Research Committee.—RICHARD M. HANSEN, *Department of Vertebrate Zoology, University of Utah, Salt Lake City, Utah.* *Received February 23, 1952.*

NOTES ON PIKAS FROM THE OREGON CASCADES

Knowledge of the distribution and habits of the pika (*Ochotona princeps*) is far from complete, and the following additional information may be of interest. Observations were made during the fall of 1949 and the summer, fall, and winter of 1950, in the north and central parts of the Oregon Cascades. All specimens collected are now in the Oregon State College Museum of Natural History.

Pikas were noted in the following locations, some of which constitute range extensions.

Slide below Sheldon Point, on Larch Mountain, Multnomah County, 3900 feet.

Large slide area just east of Multnomah Falls, Multnomah County. Pikas found here as low as 125 feet; one specimen, a young female, August 26, 1950.

One-half mile west of Wyeth, and one mile east of Wyeth, Hood River County, in slides at the foot of the Columbia Gorge cliffs, 200 feet; one male, 160 grams, with 12-mm. testes, December 29, 1950.

Loose slide just below Inspiration Point, half way up the road to Cloud Cap Inn, Hood River County, 4500 feet.

Road fill one-quarter mile below Timberline Lodge, Multnomah County, 5625 feet.

Pamelia Lake, in a slide at the lake outlet, Linn County, 3950 feet; one young male (54 grams), and a 204-gram female with three 33-mm. embryos, July 26, 1950. This is the type locality for *O. p. fumosa*.

Road fill at Tombstone Prairie, Santiam Highway, Linn County, 4130 feet.

In the lava 3.3 miles west, and also one-half mile northwest of the Santiam Junction, Linn County, 4300 feet; one 240-gram female with three 50-mm. embryos, July 15, 1950.

Rock slides on all faces of Hogg Butte, at the summit of the Santiam Pass, Linn County, elevations between 4700 and 4900 feet; adult male with 12-mm. testes, June 18, 1950, and a young male, July 15, 1950.

Road fill one-half mile east of the Linn-Jefferson County line, in Jefferson County, on the Santiam Highway, 4800 feet; young male, July 15, 1950; adult male and female, Sept. 15, 1950; male, October 13, 1950.

Gravel quarry one-half mile south of Belknap Springs, Lane County, 1600 feet.

One mile east of Lost Creek Ranch, McKenzie Highway, Lane County, 2200 feet.

In the lava edge at West Lava Camp, McKenzie Highway, Lane County, 5000 feet.

In rocks above lava at Windy Point, McKenzie Highway, Deschutes County, 4900 feet.

Lava edge at Elk Lake and Devil's Lake, Deschutes County, 4900 and 5530 feet, respectively. Two males from Elk Lake, September 10, 1950.

In the crater of Lava Butte, on U. S. Highway 97, Deschutes County, 5026 feet.

Obsidian flow at the south shore of Lost Lake, in Newberry Crater, Deschutes County, 6400 feet.

One-half mile west of Salt Creek Falls, along the Willamette Highway, Lane County, 4000 feet.

The last locality fills partially a large gap between the ranges of *O. p. fumosa* (at Elk Lake) and *O. p. brunnescens* in the vicinity of Crater Lake. Unfortunately no specimens could be obtained. The localities along the Columbia River are at the lowest elevations known in the United States.

Taylor and Shaw (Mammals and Birds of Mount Rainier National Park, Nat'l. Park Service, Washington, 1927) mention the occasional burrowing habits of pikas on Mount Rainier. Burrows under stones and tree roots were also discovered at Pamelia Lake and Hogg Butte. They were usually in areas where the slide had been somewhat overgrown with vegetation, but some were true burrows in soil at the edge of the slide.

Various authors state that the pika does not sit erect with forefeet off the ground. On July 15, 1950, at the Santiam Junction locality, I saw one squat and rub its face with both forepaws. In captivity they frequently stretched up to sniff the top of the cage, sitting erect somewhat like a ground squirrel. Bill Lauderback, at the Santiam Lodge, near the Santiam Pass, told me of a family group which lived in the woodpile behind the lodge, members of which he had seen sit up, "like little rabbits."

The following parasites were noted: one tapeworm, with scolex missing, from the adult female from Pamelia Lake; six nematodes, *Dermatoxys* sp., all females, from the large intestine of the specimen taken near Wyeth; several ticks, *Dermacentor andersoni*, from specimens taken at Elk Lake and Hogg Butte; fleas, *Ctenophyllus terribilis*, one from Multnomah Falls, two from Pamelia Lake, and one from Hogg Butte, and two *Malareus bitterrootensis* from a specimen taken at Elk Lake; one larval warble fly, Family *Hypodermatidae*, from behind the left shoulder of the specimen from Multnomah Falls.

On October 13, 1950, between 5:30 and 7:30 P.M., two live pikas were caught one-half mile east of the Linn-Jefferson County line. Six box traps were set in runways along the foot of the road fill. The animals had apparently blundered into the traps by accident, rather than being attracted by the dried prune bait. In captivity, they ate rolled oats, commercial rabbit pellets, carrots, apples, celery, grass, and Port Orford cedar twigs. Considerable water was lapped up from a bowl.—ARYAN I. ROEST, *Museum of Natural History, Oregon State College Corvallis, Oregon.* *Received January 25, 1952.*

NOTES ON MAMMALS OF ANASTASIA ISLAND, ST. JOHNS COUNTY, FLORIDA

In February, 1948, three trips were made to Anastasia Island, St. Johns County, Florida, for the purpose of obtaining topotypes of the Anastasia Cotton Mouse, *Peromyscus gossypinus anastasae* (Bangs). The following notes are presented as supplements to the somewhat meager data available on the mammals of this island.

Unlike the Sea Islands extending to the north which are connected with the coast through extensive areas of salt marsh, Anastasia Island retains its entity by virtue of a tidal lagoon, the Metanzas River, which completely separates it from the mainland. This lagoon joins the ocean by means of narrow, deep inlets.

According to Cooke (1939: 63) the island, which is approximately 14 miles in length, ". . . is composed in large part of parallel ridges of loosely cemented coquina, or shell rock, rising 10 to 20 feet above sea level, separated by marshy swales. This coquina seems to have accumulated as a succession of slightly submerged bars when sea level stood 25 feet higher than now, during the Pamlico epoch."

The comparatively narrow dune strip adjacent to the ocean beaches, composed usually of two or more rows of successively older dunes, is dominated by sea oat (*Uniola paniculata*)

and other grasses. Further inland are scrubby areas of wind-twisted scrub oaks, *Yucca*, *Opuntia*, and *Smilax*, with little or no ground cover present in many places. There are also extensive regions of salt marsh, much of which has undergone recent burning, and further inland, hammocks of live oak, magnolia, cedar, cabbage palm, and saw palmetto. In several places excavations, overgrown with vegetation and partially filled with seepage water, are momentos of quarrying activities which have been carried on since the days of the Spanish settlers.

Forty-eight individuals, representing six species, were taken in four nights of trapping. Forty-seven of these were taken in 306 trap-nights using Sherman live traps baited with cornmeal, or a rolled oat-peanut butter mixture. One mole, *Scalopus aquaticus anastasae*, was captured in an Out-O-Sight mole trap. In addition to these, a Seminole bat, *Lasiurus seminolus*, was secured by hand from the trunk of a small cedar tree.

It is considered noteworthy that no cotton mice were taken, although special efforts were made to capture this rodent. Much of our trapping was done in the vicinity of Point Romo, the type locality. Here Bangs (1898: 196) mentions taking nine individuals from the open sand hills. Thaddeus Surber, in 1901, collected ten specimens at 'Espanita,' the home of a Mr. Middleton, which was located only two or three miles from Bangs' collecting locale (Elliot, 1901: 39). As far as we have been able to determine no cotton mice have been taken from Anastasia Island since Surber's collection was made.

It is quite likely that man has been important factor influencing the scarcity, or absence, of this rodent on Anastasia Island. Development of this area has been rapid in recent years. The ocean beaches attract many visitors with consequent growth of resort industries, and other types of commercialization. This, together with the establishment of homes, has markedly altered many local areas. Even though the cotton mouse is quite ubiquitous, it is primarily a woodland form. Elsewhere we have found *Peromyscus g. gossypinus*, occurring most abundantly in hydric or mesic hammocks where fallen logs, palm fronds, or other debris form abundant nesting sites (Barrington, 1949: 47; Ivey, 1949: 159; Pournelle, 1952: 3). In such situations it usually far out-numbers any other form taken in rodent traps and cover seems to be one of the most important factors governing its distribution. It is possible that the cotton mouse has not been able to adapt itself successfully to the changing environment on the island. An additional factor which may be involved is the competition afforded by the beach mouse, *Peromyscus polionotus phasma*, and cotton rat, *Sigmodon hispidus littoralis*, both of which occur here in large numbers.

Scalopus aquaticus anastasae (Bangs). Anastasia Island mole.—One mole was taken in a hammock near the northern end of the island on February 29. This animal distinctly shows the gold and orange suffusions mentioned by Bangs as being a distinguishing character of this race (1898:212). A series taken by Surber at 'Espanita,' only a mile or two from Bangs' collecting site did not show this type of coloration and could not be distinguished from *S. a. australis* of the mainland by pelage characters alone (Jackson, 1915:40). Jackson mentions the possibility of a change from a more neutral color at the time Surber's collection was made (January 25–29) to the full winter pelage as exemplified by Bangs' series (February 12–16). If this change could occur in such a short interval, the specimen taken by us may be representative of the winter pelage since it was trapped about two weeks later in the year than those taken by Bangs.

Lasiurus seminolus (Rhoads). Seminole bat.—A female Seminole bat was taken from the trunk of a cedar in a hammock at the northern end of the island in the afternoon of February 29.

Procyon lotor elucus (Bangs). Raccoon.—There were many evidences of raccoon activity on the island, i.e. tracks and molested traps. In certain areas it was necessary to check the lines soon after dark in order to re-set those traps that had been tripped by these inquisitive animals. One line set among the dunes at Point Romo was visited by an adult and a cub, judging from the well-defined tracks. Several traps were sprung and turned over. One had

been carried several yards from the spot where it had been set. Nine of fifteen traps set in a hammock were molested.

Peromyscus polionotus phasma (Bangs). Anastasia Island beach mouse.—Beach mice are quite restricted in habitat. Fourteen individuals trapped by us at Point Romo were all taken from open dunes or in the scrub not over 1800 feet back of the dunes.

Until recently this race was believed to be confined to Anastasia Island. Its range was extended to a barrier island north of St. Augustine by Ivey (1949). Our observations regarding the restricted nature of the habitat are in accord with his. He recorded them from most of the open dunes where trapping was done, but did not find them in dense saw palmetto thickets, hammocks, or grassy hollows.

Peromyscus floridanus (Chapman). Florida gopher mouse.—Five gopher mice were trapped; one from the scrub behind the dunes, three from palmetto thickets around seepage pools at the northern extremity of the island, and one from a hammock near the center of the island. This species is not reported as being taken here by Bangs. Surber, however, collected a series of ten from 'Espanita,' and considered that they were common among the scrub oaks, saw palmetto and sand hills (Elliot, 1901:39). The specimens taken by us appear no different from those from Gainesville, Florida, the type locality, or from Welaka, Putnam County, Florida.

Oryzomys palustris natator (Chapman). Rice rat.—Four rice rats were captured; one in the salt marsh and three at the edge of one of the seepage pools near the northern end of the island. Bangs (*op. cit.*, 168) took several "... on the barren sand hills."

Sigmodon hispidus littoralis (Chapman). Hispid cotton rat.—Cotton rats were taken from practically every type of habitat in which traps were placed. Twenty-one individuals were trapped as follows: Hammock, five; Scrub, nine; Palmetto thickets, three; Marsh (burned over), three; Dunes, one. Bangs (*op. cit.*, 168) writes, "The cotton rat lives there literally by the thousand, and even such a marsh-loving animal as the rice-field mouse can not resist its fascinations. . . ."

As mentioned above, it is possible that the cotton rat offers severe competition to the cotton mouse and may be a factor in the latter's scarcity.

Rattus rattus alexandrinus (Goeffroy). Roof rat.—Three roof rats were captured, all from scrubby areas. Another was found on the highway where it had been struck by a passing car.

Other species recorded from Anastasia Island are the opossum, *Didelphis virginiana pigra* (Elliot, 1901:32), The black bear, *Ursus floridanus* (Bangs, 1998:221), and marsh rabbit, *Sylvilagus p. palustris* (Nelson, 1909:269).

LITERATURE CITED

Bangs, O. 1898. The land mammals of peninsular Florida and the coast region of Georgia. Proc. Boston Soc. Nat. Hist., 28: 157–235.

Barrington, B. A., Jr. 1949. Mammals of a north Florida Flatwoods. Doctor's Dissertation, Univ. Florida, 1–93.

Cooke, C. W. 1939. Scenery of Florida interpreted by a geologist. Fla. Geol. Surv. Bul., 17: 5–118.

Elliot, D. G. 1901. A list of mammals obtained by Thaddeus Surber in North and South Carolina, Georgia, and Florida. Field Columbian Mus., zool. ser., 3: 39–57.

Ivey, R. 1949. Life history notes on three mice from the Florida east coast. Jour. Mamm., 30: 157–162.

Jackson, H. H. T. 1915. A review of the American moles. N. A. Fauna, 38: 3–100.

Nelson, E. W. 1909. The rabbits of North America. N. A. Fauna, 29: 1–314.

Pournelle, G. H. 1952. Reproduction and early post-natal development of the cotton mouse, *Peromyscus gossypinus gossypinus*. Jour. Mamm., 33: 1–20.

George H. Pournelle and B. A. Barrington, *828 Salem Court, San Diego, California, and King College, Bristol, Tennessee.* *Received February 3, 1952.*

UNUSUAL RUTTING OF A CAPTIVE WAPITI STAG

The rutting of a captive wapiti herewith reported seems unusual for three reasons. First, the date was mid-February; second, the object that excited the rutting behaviour was a Japanese sika doe; and third, according to Murie's observations (The American Elk: 123-4, 1951) the rutting may also be somewhat unusual in view of the age of the animal concerned —a 19 to 20 months-old male, found as an orphan calf on a farm in northern Manitoba in July, 1950, raised on a bottle and sent to the Winnipeg Zoo as a yearling in the summer of 1951.

Since his arrival at the Winnipeg Zoo the young wapiti stag has been kept with three Japanese sika, one young male and two females believed to be rather old. Through the late summer and fall they were together in a fair-sized grass paddock. At about the beginning of winter they were moved to a yard some 70 feet square.

On Tuesday, February 12, as I approached the yard I heard the young wapiti calling, not with the distinctive bugle of a mature rutting stag, but with the ordinary squeal commonly used by wapiti hinds. When I reached the yard, it was apparent that he was much excited by one of the sika does who had unseasonably come into heat. He was doing a lot of running up and down, and (though he is usually quiet) he two or three times charged at people close to the high wire fence of the yard. Several times in the half hour that I was able to watch he attempted to serve the sika doe, though his height made it impossible for him to do so successfully. He may have ejaculated in these attempts as the doe's coat appeared moist along her spine, neck and head. He was, however, licking the female from time to time, and this might have caused the moisture, and I did not actually see ejaculation occur; nor, on the one occasion when I saw it extruded, did his penis appear to have the rigidity observable in a fully mature male wapiti in the normal rutting season. The record of wapiti calves born in October, however, (Murie, *op. cit.*: 133) would suggest that a stag is quite capable of ejaculating active semen at about this season.

Two days later, on February 14, Mr. T. R. Hodgson, Superintendent of the Winnipeg Parks, found the young wapiti still in a state of excitement. Though Mr. Hodgson did not see him try to cover the sika, his excitement may still be interesting as an indication of the length of a female sika's period of heat. Mr. George Grantham, senior keeper at the Winnipeg Zoo, first observed her to be in this condition on the evening of the 11th.

Mr. Hodgson, as well as myself, observed that the sika doe was very ready to receive the wapiti's advances, but the young sika buck in the same enclosure was noticeably upset by these goings on. He tried to keep out of the wapiti's way, but as the wapiti was very active, and the yard small, this was not easy. When the wapiti came toward him, he would back away, offering his horns as he did so. Once I saw him jab the wapiti in the thigh. Fortunately, the wapiti was very ready to ignore him. Since this excitement subsided, the wapiti has been moved to another yard, but the young sika buck perhaps nurses a grudge against the female who was the cause of it all; at any rate I have seen him attack her with his antlers, when he appeared tolerant enough of the other doe.

In connection with this incident, there may be point in recalling the observation of G. K. Whitehead, in his recent and valuable study of deer in British parks (Deer and Their Management in the Deer Parks of Great Britain and Ireland. London: 194, 1950). that "Sika Deer seem to have more inclination for hybridism than any other species of deer, and, at Woburn there have been several cases of Manchurian sika crossing with Malayan sambar, red deer and other species of sika". The present Duke of Bedford also states that his father acquired an apparent hybrid between a Pekin sika "and one of the Asiatic Wapitis" (Years of Transition. London: 248, 1949). In view of the facts that the great Asiatic deer of wapiti type are generally smaller than their American counterpart, while the Pekin sika is much larger than the Japanese, such a cross seems entirely possible. The animal referred to was a male and proved a fertile sire. It also seems noteworthy that the Duke observes that "the act of copulation is very rarely witnessed" in any species of deer, except Père David's deer, (Proc. Zool. Soc. London, 121: 331, 1951) from which it may be inferred that mating normally takes place at night, and a similar observation is made by Fraser Darling in his study

of the Scottish red deer (A Herd of Red Deer. Oxford: 177, 1937); but this young wapiti several times attempted to mount the sika in mid-afternoon.

Finally, the antlers of the young wapiti may be of interest. His first antlers, each produced a small, but well-shaped, brow tine. From O. J. Murie's recent study of the American elk it would appear that such antlers are not very usual in a yearling.—Richard Glover, *Zoo Advisory Committee, Winnipeg Board of Parks & Recreation, Winnipeg, Canada.* *Received March 6, 1952.*

A BAIT FOR SMALL MAMMALS

The University of Colorado Museum has had very satisfactory results using a small mammal bait made up in the following proportions: Roman meal, 1 lb.; beef suet, ground fine, 1 lb.; raisins, ground fine, 1 lb.; peanut butter, 1 qt.

Previously we had used a mixture of rolled oats, bacon grease, ground raisins and peanut butter.

Our first alteration was to substitute ground beef suet for the bacon fat and we found the mixture much easier to use. It was more plastic and small chunks could be stuck to the trap surface much more easily. The mixture also withstood hot weather much better.

Later we substituted Roman meal for rolled oats and found the mixture withstood rain very well, not swelling up and disintegrating in the presence of moisture the way a rolled oats bait does.

So far we feel that the catches with the new bait are as good or better than those with the old mixture and it gives the advantage of easier handling.—Lowell E. Swenson, *University of Colorado Museum, Boulder, Colorado.* *Received February 9, 1952.*

MAMMAL HOST RECORDS OF ACARINA AND INSECTA FROM THE VICINITY OF LONDON, ONTARIO

In a previous paper (Journal of Mammalogy, 31: 357-358, 1950) the writer reported upon ectoparasitic ticks, mites, and insects collected from mammals in Wentworth, Halton and Elgin Counties in Ontario. Since then an opportunity has been taken to study ectoparasites in the collections of the University of Western Ontario, taken from mammals, mainly in the vicinity of London (Middlesex Co.), Ontario. Unless otherwise stated, all collections mentioned in the following list as being from London were made by Mr. D. McMillan who removed parasites from small mammals trapped by him in fields adjacent to the campus of the University of Western Ontario, while collections not from London were made by Mr. J. K. Reynolds. All specimens are in collections at the University of Western Ontario except series retained at the U. S. National Museum, Washington, D. C. (USNM) and the Ontario Research Foundation, Toronto, Ontario (ORF) as indicated in the list. Each dated entry represents a collection from a single host. Some individual hosts yielded several species of parasites, e.g. a skunk, *Mephitis mephitis*, from which mites, psocids, biting lice, and fleas were taken.

Identifications in several of the taxonomic groups were kindly made by taxonomists of the U. S. National Museum. Dr. C. F. W. Muesebeck identified Anoplura, Mallophaga, and Siphonaptera; Dr. A. B. Gurney identified Corrodentia; Dr. F. C. Bishopp identified *Haemaphysalis* and Dr. E. W. Baker identified *Spinturnix* and *Hirstionyssus*. Dr. H. H. J. Nesbitt, Carleton College, Ottawa, Ontario identified mites; Dr. G. M. Kohls, U. S. Public Health Service, Hamilton, Montana identified *Ixodes angustus* and Dr. D. M. Davies, Ontario Research Foundation, Toronto, Ontario identified some of the Anoplura and Siphonaptera.

Acarina

laelaptidae

Atricholaelaps glasgowi (Ewing).—Hosts: *Blarina brevicauda* (Say), November 2, 8, 10, 1950, London; *Microtus p. pennsylvanicus* (Ord), October 3, 13, 31, November 2, 6, 8, 10, 1950, London.

Laelaps microti (Ewing).—Host: *Microtus p. pennsylvanicus* (Ord), October 30, 31, November 6, 1950, London.

Laelaps muris Ljungh.—Host: *Microtus p. pennsylvanicus* (Ord), November 2, 1950, London.

Hirstionyssus sp.—Host: *Mephitis mephitis* (Schreber), (to U.S.N.M.), July 17, 1950, Stratford (Perth Co.).

PARASITIDAE

Spinturnix (echinipes Banks?).—Host: *Eptesicus fuscus* (Beauvois), (to USNM), August 25, 1949, Wilmot Twp., Waterloo Co.

IXODIDAE

Ixodes angustus Newmann.—Host: *Blarina brevicauda* (Say), nymph and larvae (to ORF), July 23, 1949, Wilmot Twp., Waterloo Co.

Dermacentor variabilis (Say).—Host: *Canis familiaris* L. (collie), 1 engorged ♀, July, 1934, Byron (Westminster Twp., Middlesex Co.), G. Sharp.

Haemaphysalis leporis-palustris Pack.—Host: *Lepus europaeus* Pallas, June 13, 1951, Glenelg. Twp., Grey Co.

CORRODENTIA

PSOCIDAE

Psocus (purus Walsh?).—Host: *Mephitis mephitis* (Schreber), 1 nymph, July 17; 1950, Stratford.

MALLOPHAGA

TRICHODECTIDAE

Neotrichodectes mephitidis (Pack).—Host: *Mephitis mephitis* (Schreber), 12 lice (6 to USNM), July 17, 1950, Stratford.

ANOPLURA

HAEMATOPINIDAE

Linognathus piliferus (Burm.).—Host: *Canis familiaris* L. (spaniel), October 7, 1947, Hamilton (Wentworth Co.), P.J.F. Baker.

Hoplopleura acanthopus (Burm.).—Hosts: *Blarina brevicauda* (Say), (to USNM), November 10, 1950, London; *Microtus p. pennsylvanicus* (Ord), October 30, 31, 1950, London.

Haemodipsus (ventricosus Denny?).—Host: *Lepus europaeus* Pallas, July 8, 1949, East Oxford Twp., Oxford Co., (to ORF) July 11, 1949, Wilmot Twp., Waterloo Co., August 5, 1949, Dumfries Twp., Brant Co., (to ORF) August 11, 1949, Maryborough Twp., Wellington Co., August 12, 1949, Mornington Twp., Perth Co.; 7 lice (4 to USNM), June 13, 1951, Glenelg Twp., Grey Co.

SIPHONAPTERA

PULICIDAE

Cediopsylla simplex (Baker).—Host: *Lepus europaeus* Pallas, 6 fleas (3 to USNM) May 30, 1950, Yarmouth Twp., Elgin Co.

HYSTRICHOPSYLLIDAE

Epitedia wenmanni (Roths.).—Hosts: *Blarina brevicauda* (Say), (to USNM), November, 2, 1950, London; *Vulpes fulva* (Desmarest), (to USNM) January 1, 1952, McGillivray Twp., Middlesex Co.

CERATOPHYLLIDAE

Oropsylla arctomys (Baker).—Host: *Vulpes fulva* (Desmarest), (to USNM) January 1, 1952, McGillivray Twp., Middlesex Co.

Orchopeas leucopus (Baker).—Host: *Peromyscus* sp., (to ORF) August 21, 1949, Wilmot Twp., Waterloo Co.

Megabothris asio asio (Baker).—Host: *Mephitis mephitis* (Schreber), (to USNM) July 17, 1950, Stratford.

ISCHNOPSYLLIDAE

Myodopsylla insignis (Roths.).—Host: *Myotis lucifugus* (Leconte), (to ORF) August 16, 1949, Wilmot Twp., Waterloo Co.—W. W. Judd, *Department of Zoology, University of Western Ontario, London, Canada.* *Received March 3, 1952.*

REVIEWS

Burt, William Henry, and Richard Philip Grossenheider. A Field Guide to the Mammals. Houghton Mifflin Company, Boston. xxi + 200 pp., 37 pls. (24 color), 52 maps. 1952. Price, $3.75.

The science of mammalogy, particularly systematics and ecology, was given great impetus by the development of the cyclone trap and the later refinements which resulted in the snapback trap so widely used today. Large series of mammals could be obtained with relatively little effort, and descriptive mammalogy came into its own. Collections increased a hundredfold in a decade or so after the appearance of these small but effective instruments. New species were described at an astonishing rate. Increasing attention was directed to mammals; the subsequent reports and local lists added still further impetus to this hitherto neglected field. Biologists have long awaited a reference work that would help them determine the species in the field. Anthony's *Field Book of North American Mammals* has been most useful for the past quarter century. We now have a superb field guide which will surely attract many thousands to the still relatively unexplored field of living mammals.

In *A Field Guide to the Mammals* Dr. Burt has made a much needed and excellent contribution. The care with which he has assembled an amazing amount of data is evident. While the accounts are carried only to species, 373 mammals occurring north of the Mexican boundary are treated in the text. Brief descriptions of each species, chiefly outlining recognition marks and a list of similar species, distribution maps of all but the cetaceans and pinnipeds, and a short account of the habitat are given. If the reader should be confused by the similarity of related species, the distributional limits will help in making a determination. The book is remarkably easy to use, the lucid instructions, plates, maps, and figures all providing clues for rapid identification. The photographs of skulls are among the best that have appeared, and indicate diagnostic characters which will be of help to many. They are supplemented by a table listing the dental formulae of all the genera treated in the text, so arranged that the identification from the skull alone will be sufficient to place the specimen in the correct genus with little effort. Recent references list the state and provincial reports on mammals. These references will aid the student in his search for subspecific details.

Grossenheider's artistry is at its best, the remarkably life-like portraits being the best we have seen. This is undoubtedly the finest collection of colored plates of mammals yet to appear in an American publication; many species are figured in color for the first time. I suspect that the tyro will use these for a cursory determination. He will experience difficulty with the shrews if color alone is considered. These little beasts are notoriously hard to portray; the minor differences between species are often so subtle that the experienced collector often experiences difficulty. The tracks of most of the genera in the book are figured with a scale which will be useful. The drawings are exceptionally well done.

Errors are remarkably few. I am sure the author did not mean that *Sciurus niger* occurs wherever there are nut trees in the east. Hickories, oaks, and walnuts occur in New England, but the fox squirrel is unknown there. The expression, "sharply bicolored tail", is not, to the reviewer, a good field character for separating the northeastern species of *Peromyscus*, some of which occupy identical habitat. *Glaucomys volans* cannot always be separated from the larger *sabrinus* by the color of the belly fur, a presumed identification character that has often been indicated. The rice rat is stated to be nocturnal, implying that it does not move about by day. Perhaps such terms should be qualified. We are not yet sufficiently familiar with most small mammals to speak with complete finality of their activity. Surely *Oryzomys*, and I suspect, most small mammals, may be up and about at any time. Even the deer mice, which are proverbially creatures of the night, occasionally move about in the daytime. There should be no question of the natural occurrence of coyotes in the eastern states, as the range map implies. Those that have become established are by no means all dog-coyote hybrids.

Since the animals treated are carried only to species, some confusion will undoubtedly arise in fixing the identity of the species of *Peromyscus*, where ranges of two overlap. Special works can be consulted for these problematical forms.

While *A Field Guide to the Mammals* was presumably designed for the amateur, the professional mammalogist will find much of value in its pages. Indeed, it will be indispensible for those who travel unfamiliar regions of North America, be it on land or the coastal waters and shores of either ocean. This is one guide that will not be left in the study when next I go traveling.—W. J. Hamilton, Jr., *Cornell University.*

Roberts, Austin. The Mammals of South Africa. xlviii + 700 pp., illus., May, 1951. Published by "The mammals of South Africa" book fund and distributed by the Central News Agency of South Africa. Price, 57 shillings, 6 pence.

This book, edited by R. Bigalke, V. FitzSimons and D. E. Malan, after Dr. Roberts' death, is a comprehensive work covering the mammals of South Africa from the Cunene and Zambesi rivers in the north to the extreme southern tip of the continent.

The introduction covers, in a general way, the definition of a mammal; classification of animals as regards the higher categories of taxonomy; neozoology and paleontology; the status of the genus, species and subspecies; definition and delimitation of some 26 geographical subregions; the history of mammalogy in South Africa; a plea for the protection of wildlife; economic relationships of mammals to man; native names of mammals; and definitions of measurements used in the tables.

The systematic arrangement of the volume is slightly at odds with the concept of phylogenetic arrangement of mammals as generally understood, in that the first order to be treated is the Primates. Next are the orders Menotyphla and Lipotyphla which are usually suborders of the order Insectivora. It may well be that this is the correct arrangement and that the majority use the term Insectivora for want of acceptance of the other categories. These orders are followed by the Chiroptera, which in turn is followed by the order Chrysochloridea for the golden moles, which latter group is generally considered only as a family in the order Insectivora, but which is so different that perhaps again the ordinal status should be accepted. The rest of the ordinal groups are the usually accepted ones with the exception of the order Nomarthra which is generally called Pholidota. The last two orders are Rodentia and Lagomorpha. In spite of the usage of some ordinal names, the taxonomy as expressed at the generic and specific level is exceptionally good for such a tremendous fauna.

The text of the volume is set up with the scientific name in bold face capitals so that it easily catches the eye. This name is then followed by a synonymy where needed, a paragraph or more of description and comparison, and a statement of distribution of the kind. In each case the type locality follows the citation of the original description. Usable keys are given where there is more than one species to a genus or more than one subspecies in a species.

The color illustrations are remarkably good, and the artist, Rev. P. J. Smit, is to be commended. The photographic plates of skulls leave something to be desired, but even so they are very useful. Almost every species is represented by a color painting or an illustration of the skull.

The legends for, and under the species guide to, colored plates V and VI are hopelessly confused. It is regrettable that this mishap occurred. Otherwise all legends for the plates are accurate.

The last section of the book is devoted to some 130 pages of tables of measurements of specimens examined. A bibliography and an index to scientific and common names complete the volume.

Four names, *Ictonyx kalaharicus ovamboensis*, *Cryptomys komatiensis zuluensis*, *Gerbillus paeba swakopensis* and *Lamotomys laminatus fannini*, are proposed as new.

In the treatment of the kinds of mammals, Dr. Roberts gives diagnostic characters of the genus, general statements of habits and distribution and, where known, breeding data. This information is given under the generic heading and if there is any variation from the general pattern it is discussed under the appropriate species.

Considerable information is given as a result of Dr. Roberts' own observations, but also he has relied upon other authors to complete and augment his own observations.

The volume is exceptionally well written, and, owing to the excellent plate showing the nomenclature applied to the features of the skull and the definitions of measurements taken the amateur as well as the professional mammalogist may use the keys and descriptions with equal facility.

Taken as a whole this work ranks well above most faunal studies of recent years. It is a volume that has been sorely needed for many years. The editors, the trustees of the Book Fund and the Central News Agency all are to be commended for their efforts in producing from Dr. Roberts' manuscript a genuinely worthwhile addition to the knowledge of mammals from an extremely interesting section of the world.—Henry W. Setzer, *Division of Mammals, U. S. National Museum, Washington, D. C.*

Whitney, Leon F., and Acil B. Underwood. The Raccoon. Practical Science Publishing Co., Orange, Conn. 177 pp., illus. 1952. Price, $3.75.

This splendid little volume is authored by a veterinarian and a coon rancher. Dr. Whitney, known for his studies on dogs in general, and the bloodhound in particular, has been an avid student of the raccoon for the past thirty years. Acil Underwood, a lifetime student of the coon and owner of the largest raccoon ranch in North America, is eminently qualified to write on the coon through his vast knowledge of this animal, not alone on captives but through his knowledge of this fine animal in the wild. For he, like Whitney, is a breeder of fine coon hounds. They have followed the trails of "ringtail" together over the years.

Professional biologists are often disparaging in their reviews of reports that presumably invade on their field, particularly specific reports that might conceivably dispel illusions that have long been held as accepted fact. Students of the raccoon, or mammals in general, will be amazed at the studies that have been made on our ringtail.

The eighteen chapters include, in part, reports on habitat, physical characters, varieties, food, reproduction, enemies and disease, parasites, laws that govern the taking of this animal, care in captivity, and other phases of the life of this intriguing species. Each chapter is exceptionally well documented with pertinent literature; included is an additional bibliography of more than 300 references that attest the serious search of the literature.

A close reading of the book reveals many items of interest to the professional mammalogist. We learn that flying squirrels, upon occasion, may be found in hibernation; this knowledge is reflected in our own recent observations of a similar state in deer mice, a suggestion that would have been heresy a decade ago.

The opportunity that experienced coon hunters have, particularly those scientifically bent and those trained in the lore of variation, is evident in this study. It is one matter to gauge specific distinctions in a museum series, quite another to "feel" and observe the

variation in a large number of animals taken in one place. Here the differences are apparent; the large numbers from one locality showing a range in size and color that might well amaze and disconcert the systematist who has not a composite collection from a single locality.

Surprisingly few errors appear in the book. On page 76, we read "When raccoons are plentiful, the game birds are scarce. In sections away from man's 'improvements' on nature, where birds are numerous, one is fairly safe in assuming that raccoons will not be found in abundance." Our studies in central New York do not bear out this thesis. To be sure, raccoons may be important predators of wildfowl on occasion, but it appears problematical that they have any serious effect on bird populations.

While they indicate the coon is not a true hibernator, there is no sharp line drawn between dormancy, semi-hibernation and hibernation. Surely there is a sharp distinction. Dormancy should imply a quiescent state, usually in the colder months of the year, in which the animal retains all of its faculties. One must include the bear, skunk, opossum and raccoon in this category.

This is a rare little volume on a single American mammal, combining the efforts of two devoted disciples of the raccoon. The authors dispel many beliefs and illusions, and add measurably to our knowledge of the beast. It is unfortunate that more of their breed do not recount observations seen in every month for many years. To do this one must have the incentive and the gift for portraying the details that have been laboriously accumulated in field notes.—W. J. HAMILTON, JR., *Cornell University.*

RECENT LITERATURE

(Conducted by David H. Johnson, Claude W. Hibbard, Richard H. Manville, and Henry W. Setzer)

[Reprints of this section may be purchased from the Corresponding Secretary]

ANONYMOUS. Rabbits on Leper Island (Mokopuna). Forest & Bird, Wellington, New Zealand, no. 102, p. 11. November, 1951.

ANONYMOUS. Opossums mob cat. Forest & Bird, Wellington, New Zealand, no. 102, p. 7. November, 1951.

ANONYMOUS. Hjälpfodringen aktuell. Svensk Jakt, Stockholm, vol. 89, no. 12, p. 333, illus. December 20, 1951.

ANONYMOUS. Some materials showing the status of whaling of Japan (II). Fisheries Agency Japanese Govt., Tokyo, Publ. Japan Whaling Assoc., pp. 19, illus. 1952.

ANONYMOUS. Rules and regulations under the Fur Products Labeling Act. Text of fur products name guide and act appended. Federal Trade Commission, Washington, pp. 29. 1952.

ATKESON, THOMAS L., AND DAVID C. HULSE. Crippling as a factor in gray squirrel hunting. Jour. Wildlife Management, Ithaca, N. Y., vol. 16, no. 2, pp. 230–232. April, 1952.

BAKER, ROLLIN H. Geographic range of Peromyscus melanophrys, with description of new subspecies. Univ. Kansas Publ., Mus. Nat. Hist., Lawrence, vol. 5, no. 18, pp. 247–258. April 10, 1952. (New: *Peromyscus melanophrys micropus, P. m. coahuilensis*).

BARK, LARS, AND A. LUNDSTRÖM. Ett nytt fynd och en ny lokal för dvärgvessla, Mustela minuta Pomel i Sverige. Fauna & Flora, Stockholm, vol. 3, pp. 81–86. 1952.

BEMMEL, A. C. V. VAN. Contribution to the knowledge of the genera *Muntiacus* and *Arctogalidia* in the Indo-Australian Archipelago (Mammalia, Cervidae & Viverridae). Beaufortia, Zool. Mus. Amsterdam, no. 16, pp. 1–50, illus., folding tables. May 7, 1952.

BENCHLEY, BELLE J. Koalas! San Diego Zoonooz, vol. 25, no. 3, pp. 2–4, illus. March, 1952.

BIGALKE, R. Wild life conservation in the Union of South Africa. Fauna & Flora Transvaal, Pretoria, no. 1, pp. 5–42, illus. April, 1950.

BIGALKE, R. The discovery of the giraffe in South Africa. Fauna & Flora Transvaal, Pretoria, no. 2, pp. 24–28, illus. 1951.

BLOMBERG, ROLF. Såna Djur Fins. Hugo Gebers Förlag, Stockholm, pp. 239, illus. 1951.

BODE, NANCY. Leaf eaters. Monkeys with hysterical responses and pockets in their stomachs. San Diego Zoonooz, vol. 24, no. 12, pp. 2–3, illus. December, 1951.

BOURRET, RENÉ. Une nouvelle chauve-souris du Tonkin. Bull. Mus. Nat. Hist. Nat., Paris, ser. 2, vol. 23, no. 6, pp. 607–609. December, 1951. (New: *Rhinomegalophus, R. paradoxolophus*).

BRAKHAGE, GEORGE K., AND FRANK W. SAMPSON. Rabies in beaver. Jour. Wildlife Management, Ithaca, N. Y., vol. 16, no. 2, p. 226. April, 1952.

BREWER, JOSEPH P. Gilchrist's whale. Texas Game & Fish, Austin, vol. 9, no. 7, pp. 24–25, illus. June, 1951.

BRIDGES, WILLIAM. R for man or beast. Animal Kingdom, New York, vol. 54, no. 2, pp. 34–42, illus. April, 1951.

BRIDGES, WILLIAM. There's still a chance for the wisent. Animal Kingdom, New York, vol. 54, no. 3, pp. 77–79, illus. June, 1951.

BROOM, R., AND J. T. ROBINSON. A new subfossil baboon from Kromdraai, Transvaal. Ann. Transvaal Mus., Pretoria, vol. 21, pt. 3, pp. 242–243. May 9, 1950. (New: *Parapapio coronatus*).

BROOM, R. Some further advances in our knowledge of the Cape golden moles. Ann. Transvaal Mus., Pretoria, vol. 21, p. 3, pp. 234–241, illus. May 9, 1950. (New: *Chrysochloris asiatica taylori, C. a. visserae, C. visagiei, Chlorotalpa shortridgei, Eremitalpa granti cana.*)

BROOM, ROBERT, AND J. T. ROBINSON. Swartkrans ape-man, Paranthropus crassidens. Transvaal Museum, Pretoria, Union of South Africa, pp. ix + 123, illus. 1952.

BURMAN, EDOR. Nomaden jagar älg. Svensk Jakt, Stockholm, vol. 89, no. 11, pp. 316–317, illus. November 20, 1951.

BUXTON, A. P. Further observations of the night-resting habits of monkeys in a small area on the edge of the Semliki Forest, Uganda. Jour. Animal Ecol., London, vol. 20, no. 1, pp. 31–32. May, 1951.

CARRARA, ITALO SANTIAGO. Lobos marinos, pinqüinos y guaneras de las costas del litoral marítmo e islas adyacentes de la República Argentina. Special Publ. Fac. Cienc. Vet., Univ. Nac. La Plata, pp. 191–199, pls. 8. 1952.

COTT, HUGH B. The palatability of the eggs of birds: Illustrated by experiments on the food preferences of the hedgehog (*Erinaceus europaeus*). Proc. Zool. Soc. London, vol. 121, pt. 1, pp. 1–42, illus. May 22, 1951.

CRANDALL, LEE S. We are attempting to breed the platypuses. Animal Kingdom, New York, vol. 54, no. 3, pp. 89–91, illus. June, 1951.

DEKEYSER, P. L. Sur l'origene des babouins. Notes Africaines, Dakar, no. 54, pp. 60–63. April, 1952.

DERANIYAGALA, P. E. P. Elephas maximus, the elephant of Ceylon (Part II). Spolia Zeylanica, Colombo, vol. 26, pp. 161–176. December 20, 1951.

DERANIYAGALA, P. E. P. A hornless rhinoceros from the Mio-Pliocene deposits of East Africa. Spolia Zeylanica, Colombo, vol. 26, pp. 133–135. December 20, 1951.

DERANIYAGALA, P. E. P. Some mammals of the extinct Ratnapura Fauna of Ceylon (Part III). Spolia Zeylanica, Colombo, vol. 26, pt. 2, pp. 117–124. December 20, 1951. (New: *Bibos gaurus sinhaleyus, Acanthion sivalensis sinhaleyus*).

DERANIYAGALA, P. E. P. Some hippopotamuses of Ceylon, western Asia, East Africa and England. Spolia Zeylanica, Colombo, vol. 26, pp. 125–132. December 20, 1951. (New: *Hippoleakius gorgops rectiops*).

DEVOE, ALAN. Old boomer from down under. Nature Mag., Washington, vol. 45, no. 1, pp. 8–12, illus. January, 1952. (Kangaroo).

DICE, LEE R. Variation in body dimensions and pelage color of certain laboratory-bred stocks of the *Peromyscus truei* group. Contrib. Lab. Vert. Biol. Univ. Michigan, Ann Arbor, no. 57, pp. 26. June, 1952.

DORST, JEAN. Étude d'une collection de Chiroptères d'Écuador. Bull. Mus. Nat. Hist. Nat., Paris, ser. 2, vol. 23, no. 6, pp. 602–606. December, 1951.

DUSI, JULIAN L. The food habits of several populations of cottontail rabbits in Ohio. Jour. Wildlife Management, Ithaca, N. Y., vol. 16, no. 2, pp. 180–186, illus. April, 1952.

EDBERG, P. S. Saxfangst? Svensk Jakt, Stockholm, vol. 89, no. 6, p. 180. June 14, 1951.

ELDER, WILLIAM H. Failure of placental scars to reveal breeding history in mink. Jour. Wildlife Management, Ithaca, N. Y., vol. 16, no. 1, p. 110. January, 1952.

ELDER, WILLIAM H., AND CHARLES M. KIRKPATRICK. Predator control in the light of recent wildlife management concepts. Wilson Bull., Lawrence, vol. 64, no. 2, pp. 126–128. June, 1952.

ELOFF, F. C. Observations on the chondrocranium of *Rhabdomys pumilio*. Ann. Transvaal Mus., Pretoria, vol. 21, pt. 4, pp. 369–379, illus. July 6, 1951.

ELLISON, LINCOLN, AND C. M. ALDOUS. Influence of pocket gophers on vegetation of subalpine grassland in central Utah. Ecology, Lancaster, vol. 33, no. 2, pp. 177–186, illus. April, 1952.

EMMONS, C. W. Histoplasmosis: Animal reservoirs and other sources in nature of the pathogenic fungus, Histoplasma. Amer. Jour. Public Health, Albany, vol. 40, no. 4, pp. 436–440. April, 1950.

ENGELS, WILLIAM L. Vertebrate fauna of North Carolina coastal islands II. Shackleford Banks. Amer. Midland Nat., Notre Dame, vol. 47, no. 3, pp. 702–742. May, 1952.

EZZAT, M. A. E., AND S. M. GAAFAR. Tetrathyridium sp. in Sykes' monkey (*Cercopithecus albigularis*) from Giza Zoological Gardens, Egypt. Jour. Parasitol., Lancaster, vol. 37, no. 4, pp. 392–394. August, 1951.

FINLEY, ROBERT B., JR. A new piñon mouse (Peromyscus truei) from Durango, Mexico. Univ. Kansas Publ., Mus. Nat. Hist., Lawrence, vol. 5, no. 20, pp. 263–267. May 23, 1952. (New: *P. t. erasmus*).

FLEAY, DAVID. The Tasmanian or marsupial devil—its habits and family life. Australian Mus. Mag., Sydney, vol. 10, no. 9, pp. 275–280. March 15, 1952.

FORBES, STANLEY E., AND JOHN E. HARNEY, JR. The bulldozer a tool of wildlife management. Final Rept., Pittman-Robertson Project 31-R, Pennsylvania Game Comm., Harrisburg, pp. 136, illus. 1952.

FRASER, F. C. Handbook of R. H. Burne's cetacean dissections. British Mus. (Nat. Hist.), London, pp. 70. illus. May 20, 1952.

GARDELL, TORSTEN. Älgens läten. Svensk Jakt, Stockholm, vol. 89, no. 5, pp. 146–148, illus. May 21, 1951.

GARDELL, TORSTEN. Vita älgar. Svensk Jakt, Stockholm, vol. 89, no. 12, pp. 352–353, illus. December 20, 1951.

GEHA, SIGN. Och en ravjakt. Svensk Jakt., Stockholm, vol. 89, no. 6, p. 181. June 14, 1951.

GIFFORD, CLAY L., AND RALPH WHITEBREAD. Mammal survey of south central Pennsylvania. Final Report, Pittman-Robertson Project 38-R, Pennsylvania Game Comm., Harrisburg, pp. 75. 1951.

GOBLE, FRANS C. Studies on experimental Chagas' disease in mice in relation to chemotherapeutic testing. Jour. Parasitol., Lancaster, vol. 37, no. 4, pp. 408–414. August, 1951.

GODY, JUAN CARLOS. Guia y apuntes sobre la alimentacion de nutria en criadero. Misc. Pub. Ministerio de Agricultura y Ganderia, Buenos Aires, no. 337, pp. 23, illus. 1950.

GOLDMAN, EDWARD ALPHONSO. Biological investigations in Mexico. Smithsonian Misc. Coll., Washington, vol. 115, pp. xiii + 476, pls. 71. July 31, 1951.

GREEN, EARL L. The genetics of a difference in skeletal type between two inbred strains of mice. Genetics, Menasha, vol. 36, no. 4, pp. 391–409. July, 1951.

GREEN, E. L., AND W. L. RUSSELL. A difference in skeletal type between reciprocal hybrids of two inbred strains of mice. Genetics, Menasha, vol. 36, no. 6, pp. 641–651. November, 1951.

GREEN, MARGARET C. A rapid method for clearing and staining specimens for the demonstration of bone. Ohio Jour. Sci., Columbus, vol. 52, no. 1, pp. 31–33, illus. January, 1952.

GRIZZELL, ROY A., JR. Selectivity of mirror traps. Jour. Wildlife Management, Ithaca, N. Y., vol. 16, no. 1, pp. 114–115. January, 1952.

GUIGUET, C. J. Status of birds and mammals of the Osoyoos area in May, 1951. Rept. Provincial Mus. Nat. Hist. & Anthropol., Victoria, British Columbia, 1951, pp. B25–B38. 1952.

GUNVALSON, VERNON E., ARNOLD B. ERICKSON, AND DONALD W. BURCALOW. Hunting season statistics as an index to range conditions and deer population fluctuations in Minnesota. Jour. Wildlife Management, Ithaca, N. Y., vol. 16, no. 2, pp. 121–131, illus. April, 1952.

HALL, E. RAYMOND. Taxonomic notes on Mexican bats of the genus Rhogeëssa. Univ. Kansas Publ., Mus. Nat. Hist., Lawrence, vol. 5, no. 15, pp. 227–232. April 10, 1952.

HARRIS, VAN T. An experimental study of habitat selection by prairie and forest races of the deermouse, *Peromyscus maniculatus*. Contrib. Lab. Vert. Biol. Univ. Michigan, Ann Arbor, no. 56, pp. 53, illus. May, 1952.

HARRISON, J. L., AND H. C. WOODVILLE. Variation in size and weight in five species of house-rats (Rodentia: Muridae), in Rangoon, Burma. Records Indian Mus., Calcutta, vol. 47, pt. 1, pp. 65–71. March, 1949.

HART, D. S. Photoperiodicity in the female ferret. Jour. Exper. Biol., London, vol. 28, no. 1, pp. 1–12. March, 1951.

HAYNE, DON W. Zinc phosphide: Its toxicity to pheasants and effect of weathering upon its toxicity to mice. Quart. Bull. Michigan Agric. Exper. Sta., East Lansing, vol. 33, no. 4, pp. 412–425. May, 1951.

HAYNE, DON W. (Review of) Estimating game from license reports, by William J. Sondrini. Jour. Wildlife Management, Ithaca, N. Y., vol. 15, no. 3, pp. 325–326. July, 1951.

HEDIGER, H. Die Zucht des Feldenhasen (Lepus europaeus Pallas) in Gefangenschaft. [Rearing field hares in captivity]. Physiologia Comparata et Oecologia, The Hague, vol. 1, no. 1, pp. 46–62, illus. April, 1948.

HOOGSTRAAL, HARRY. Notes on Egyptian ticks (Ixodoidea). I. The genus Argas (Argasidae) in the Cairo area. Proc. Egyptian Acad. Sci., Cairo, vol. 7, pp. 114–127, pls. 1–3. 1952. (Mammalian hosts).

HOOIJER, DIRK ALBERT. Fact and fiction in hippopotamology. (Sampling the history of scientific error.) Osiris, Bruges, vol. 10, pp. 109–116. 1952.

HOOIJER, D. A. In memoriam mejuffrouw Dr. A. Schreuder 15 November 1887—2 Februari 1952. Vakblad voor Biologen, vol. 32, no. 3, p. 45. March, 1952.

HOWARD, WALTER E. The pesky pocket gopher. Spreckels Sugar Beet Bull., Sacramento, vol. 16, no. 3, pp. 21–22, illus. May–June, 1952.

HOWELL, J. C., AND C. H. CONAWAY. Observations on the mammals of the Cumberland Mountains of Tennessee. Jour. Tennessee Acad. Sci., Nashville, vol. 27, no. 2, pp. 153–158. April, 1952.

INGLES, LLOYD G. The ecology of the mountain pocket gopher, Thomomys monticola. Ecology, Lancaster, vol. 33, no. 1, pp. 87–95. January, 1952.

INGLES, LLOYD G., AND NORMAND J. BIGLIONE. The contiguity of the ranges of two subspecies of pocket gophers. Evolution, Lancaster, vol. 6, no. 2, pp. 204–207. June 21, 1952.

IRVING, LAURENCE. Climatic adaptation in Arctic and Tropic animals. Public Health Repts., Washington, vol. 66, no. 29, pp. 939–941. July 20, 1951.

ISHIKAWA, SEIICHI, YOSHIMORI OMOTE, MASAO KIJIMA, AND HIROSHI OKUDA. Thermal

decomposition of kitol. Sci. Repts. Whales Research Inst., Tokyo, no. 5, pp. 61–69. June, 1951.

JOHANSSON, T. Med trumma och lur. Svensk Jakt, Stockholm, vol. 89, no. 6, pp. 171, 174–175, illus. June 14, 1951.

JÖNSGARD, ÅGE, AND OTTAR NORDLI. Concerning a catch of white-sided dolphins (Lagenorhynchus acutus) on the west coast of Norway, winter 1952. Norsk Hvalfangst-Tidende (Norwegian Whaling Gazette), Sandefjord, vol. 45, no. 5, pp. 229–232, illus. May, 1952.

JULANDER, ODELL, AND W. LESLIE ROBINETTE. Deer—harvest or starve them? Bull. Utah Fish & Game, Salt Lake City, vol. 8, no. 8, pp. 3–5, 7. May, 1951.

KELSON, KEITH R. Speciation in rodents of the Colorado River drainage in eastern Utah. Biol. Ser. Univ. Utah, Salt Lake City, vol. 11, no. 3, pp. 1–125, maps. 1951.

KELSON, KEITH R. Comments on the taxonomy and geographic distribution of some North American woodrats (genus Neotoma). Univ. Kansas Publ., Mus. Nat. Hist., Lawrence, vol. 5, no. 16, pp. 233–242. April 10. 1952.

KELSON, KEITH R. The subspecies of the Mexican red-bellied squirrel, Sciurus aureogaster. Univ. Kansas Publ., Mus. Nat. Hist., Lawrence, vol. 5, no. 17, pp. 243–250. April 10, 1952.

KJELDSTAD, S. KR. Möte med älg. Svensk Jakt, Stockholm, vol. 89, no. 6, pp. 164–166, illus. June 14, 1951.

KOSTRITSKY, LEÓN. Las ballenas y su aprovechamiento en el Peru. Pesca y Caza, Ministerio de Agricultura, Lima, no. 4, pp. 33–48b, illus. 1952.

LAIRD, MARSHALL. Blood parasites of mammals in New Zealand. Zool. Publ. Victoria Univ. College, Wellington, no. 9, pp. 1–14, illus. 1951.

LAMPIO TEPPO. On the sex ratio, sex differentiation, and regional variation in the marten in Finland. Papers on Game Research, Helsinki, no. 7, pp. 20, illus. 1951.

LATHAM, ROGER M. The food of predaceous animals in northeastern United States. Final Rept., Pittman-Robertson Project 36-R, Report I, Pennsylvania Game Comm., Harrisburg, pp. 68, illus. 1950.

LAVELLE, FAITH WILSON. A study of hormonal factors in the early sex development of the golden hamster. Carnegie Inst. Washington, Publ. 592, Contrib. to Embryology, vol. 34, pp. 19–53. September 5, 1951.

LAWRENCE, WILLIAM H. Evidence of the age of beaver ponds. Jour. Wildlife Management, Ithaca, N. Y., vol. 16, no. 1, pp. 69–79, illus. January, 1952.

LEACH, W. JAMES. Functional anatomy of the mammal. A guide to the dissection of the cat and an introduction to the structural and functional relationship between the cat and man. Second edition. McGraw-Hill Book Co., New York, pp. x + 276, illus. 1952.

LEVI, HERBERT W. Evaluation of wildlife importations. Sci. Monthly, Lancaster, vol. 74, no. 6, pp. 315–322, illus. June, 1952.

LINDEBORG, ROBERT G. Water requirements of certain rodents from xeric and mesic habitats. Contrib. Lab. Vert. Biol. Univ. Michigan, Ann Arbor, no. 58, pp. 32. June, 1952.

LIVERSIDGE, DOUGLAS. Australia's war against the rabbit. Discovery, London, vol. 13, no. 6, pp. 190–195. June, 1952.

LUMSDEN, W. H. R. The night-resting habits of monkeys in a small area on the edge of the Semliki Forest, Uganda. A study in relation to the epidemiology of sylvan yellow fever. Jour. Animal Ecol., London, vol. 20, no. 1, pp. 11–30. May, 1951.

MACKINTOSH, N. A. The marking of whales. Norsk Hvalfangst-Tidende (Norwegian Whaling Gazette), Sandefjord, vol. 45, no. 5, pp. 236–240. May, 1952.

MANN FISCHER, GUILLERMO. Problemas biogeograficos de la Antartica Chilena. Rev. Geogr. Chile, Santiago, no. 1, pp. 101–108, illus. September, 1948.

MANN FISCHER, GUILLERMO. Regiones ecologicas de Tarapacá. Rev. Geogr. Chile, Santiago, no. 2, pp. 51–63, illus. December, 1949.

MANN FISCHER, GUILLERMO. Tilopodos chilenos. Rev. Geogr. Chile, Santiago, no. 4, pp. 111–118, illus. October, 1950.

MANN F., GUILLERMO. Filogenia y funcion en el esqueleto de Marmosa elegans (Marsupialia. Didelphidae) (2.a Parte). Investigaciones Zoologicas Chilenas, Santiago, vol. 1, fasc. 6, pp. 6–16, illus. May, 1952.

MARTIN, ALEXANDER C., HERBERT S. ZIM, AND ARNOLD L. NELSON. American wildlife and plants. McGraw-Hill Book Co., New York, pp. ix + 500. 1951.

McHUGH, J. L. Fur seals preying on black-footed albatross. Jour. Wildlife Management Ithaca, N. Y., vol. 16, no. 2, p. 226. April, 1952.

MÉNDEZ, José Luis. Contribución al conocmiento de la región de Baruta-El Hatillo. Tercera parte. Zoologia. Estudio de los mamíferos colectados. Mem. Soc. Ciencias Naturales La Salle, Caracas, vol. 11, no. 30, pp. 203–236, illus. September–December, 1951.

MENZIES, J. I. Man and the zebra. Nature, London, vol. 169, no. 4294, pp. 275–276. February 16, 1952.

MISONNE, XAVIER. Quelques éléments nouveaux concernant Hippopotamus imaguncula Hopwood. Bull. Inst. Royal Sci. Nat. Belgique, Brussels, vol. 28, no. 3, pp. 1–12, pls. 1–3, folding table. January, 1952.

MIYAZAKI, ICHIRO. Study on maturity and body length of whales caught in the waters adjacent to Japan. Fisheries Agency Japanese Govt., Tokyo, Publ. Japan Whaling Assoc., pp. 27, figs. 29. May, 1952.

MOHR, CHARLES E. Audubon's bats. Audubon Mag., New York, vol. 54, no. 3, pp. 172–177. May–June, 1952.

MURIE, OLAUS J. The elk of North America. Stackpole Co., Harrisburg, and Wildlife Management Inst., Washington, pp. 376, illus. 1951.

NATH, BHOLA. On a collection of mammals from Chota Nagpur, Bihar. Records Indian Mus., Calcutta, vol. 48, pt. 1, pp. 29–44. March, 1950.

NEL, T. G. Questionnaire on the lion (Panthera leo). Bull. Nat. Parks Union South Africa, Pretoria no. 1, p. 2. 1951.

NEL, T. G. Discussion on certain measurements of a number of elephants (L. africana) of the Kruger National Park. Bull. Nat. Parks Union South Africa, Pretoria, no. 5, p. 1. 1951.

NEL, T. G. Specific observations in connection with animal movements on part of the lower Sabi Road. Bull. Nat. Parks Union South Africa, Pretoria, no. 6, p. 1. 1951.

NEWMAN, SANFORD B. Pigmentation in bristle and horsehair. Jour. Research Nat. Bur. Standards, Washington, vol. 48, no. 4, pp. 287–297, illus. April, 1952.

NOTINI, GÖSTA. Honom man möter-och varför! Svensk Jakt, Stockholm, vol. 89, no. 5, pp. 141–142, illus. May 21, 1951. (Badger)

OMURA, HIDEO, SETSUO NISHIMOTO, AND KAZUO FUJINO. Sei whales (Balaenoptera borealis) in the adjacent waters of Japan. Fisheries Agency Japanese Govt., Tokyo, Publ. Japan Whaling Assoc., pp. 79, pls. 5. May, 1952.

ORTIZ DE LA PUENTE, JAVIER. Estudio monografico de los quiropteros de Lima y alrededores. Publ. Mus. Hist. Nat. "Javier Prado," Univ. Nac. Mayor de San Marcos, Lima, ser. A, Zool., no. 7, pp. 48, pls. 9. December, 1951.

PARKER, HARRY C. Mammals of Yosemite National Park. Yosemite Nature Notes, vol. 31, no. 6, pp. 51–105, illus. June, 1952.

PEDERSEN, TORBJØRN. The milk fat of sperm whale (*Physeter catodon*). Norsk Hvalfangst Tidende (Norwegian Whaling Gazette), Sandefjord, vol. 41, no. 6, p. 300. June, 1952.

PEDERSEN, TORBJØRN. Oil from the meat of sperm whale (*Physeter catodon*). Norsk Hvalfangst Tidende (Norwegian Whaling Gazette), Sandefjord, vol. 41, no. 6, pp. 296–299. June, 1952.

PIAZZA L., ALVARO. Los pecaris en la selva del Peru. Pesca y Caza, Ministerio de Agricultura, Lima, no. 4, pp. 21–32. 1952.

RAND, R. W. Studies on the Cape fur seal (Arctocephalus pusillus Schreber). 3: Age-grouping in the male. Progress Report, Government Guano Islands Admin., Union of South Africa Dept. Agric., pp. 28, pls. 3. 1950.

RAND, R. W. The Cape fur seals. Farming in South Africa, Pretoria, vol. 25, no. 294, pp. 305–307, illus. September, 1950.

RAUSCH, ROBERT. Biotic interrelationships of helminth parasitism. Public Health Repts., Washington, vol. 66, no. 29, pp. 928–934. July 20, 1951.

RICHMOND, NEIL D. Fluctuations in gray fox population in Pennsylvania and their relationship to precipitation. Jour. Wildlife Management, Ithaca, N. Y., vol. 16, no. 2, pp. 198–206, illus. April, 1952.

RÖHL, EDUARDO. Fauna descriptiva de Venezuela (Vertebrados). Tipografia Americana, Caracas, ed. 2, pp. xxxvi + 495, illus. 1949. (Mammals, pp. 4–140.)

ROONWAL, M. L. Contributions to the fauna of Manipur State, Assam. Part III.—Mammals, with special reference to the family Muridae (order Rodentia). Records Indian Mus., Calcutta, vol. 47, pt. 1, pp. 1–64, pls. 1–9. March, 1949.

ROSENMÜLLER, G. Den röda döden. Svensk Jakt, Stockholm, vol. 89, no. 6, pp. 177–179. June 14, 1951.

RUUD, JOHAN T. Age-studies on blue whales. Hvalradets Skrifter, Oslo, no. 33, pp. 72. 1950.

SCHEFFER, VICTOR B., AND KARL W. KENYON. The fur seal herd comes of age. Nat. Geogr. Mag., Washington, vol. 101, no. 4, pp. 491–512, illus. April, 1952.

SEALANDER, JOHN A., JR. The relationship of nest protection and huddling to survival of Peromyscus at low temperature. Ecology, Lancaster, vol. 33, no. 1, pp. 63–71, illus. January, 1952.

SERRA, OCTAVIO DELLA, AND MILTON PICOSSE. O tuberculo intermediario posterior (metaconule) dos molares superiores nos macacos do genero Callicebus Thomas, 1903. Papéis Avulsos Dept. Zool., Sec. Agric., São Paulo, vol. 10, no. 5, pp. 127–131, illus. August 25, 1951.

SERRA, OCTAVIO DELLA. Variações do articulado dos dentes incisivos nos macacos do genero Alouatta Lac., 1799. Papéis Avulsos Dept. Zool., Sec. Agric., São Paulo, vol. 10, no. 7, pp. 139–146, illus. August 25, 1951.

SERRA, OCTAVIO DELLA. Divisão do genero Leontocebus (macacos platyrrhina) em dois sub-generos sob bases de caracteres dento-morfologicos. Papéis Avulsos Dept. Zool., Sec. Agric., São Paulo, vol. 10, no. 8, pp. 147–154, illus. August 25, 1951.

SERRA, OCTAVIO DELLA, AND MILTON PICOSSE. Sobre algumas variações das suturas do canto interno da orbita nos macacos do genero Callithrix Erxleben, 1777. Papéis Avulsos Dept. Zool., Sec. Agric., São Paulo, vol. 10, no. 14, pp. 261–266, illus. August 25, 1951.

SHANKS, CHARLES E., AND GEORGE C. ARTHUR. Muskrat movements and population dynamics in Missouri farm ponds and streams. Jour. Wildlife Management, Ithaca, N. Y., vol. 16, no. 2, pp. 138–148, illus. April, 1952.

SIMPSON, GEORGE GAYLORD. Some principles of historical biology bearing on human origins. Cold Spring Harbor Symposia on Quantitative Biology. vol. 15, pp. 55–66. 1950.

SIMPSON, GEORGE GAYLORD. History of the fauna of Latin America. Science in Progress, Yale Univ. Press, ser. 7 (edited by George A. Baitsell), pp. 369–408, illus. 1951.

SIMPSON, GEORGE GAYLORD. American Cretaceous insectivores. Amer. Mus. Novitates, no. 1541, pp. 19, illus. December 3, 1951.

STAFAS, B. Algjaktsdagar. Svensk Jakt, Stockholm, vol. 89, no. 12, pp. 352–353, illus. December 20, 1951.

STEFANSKI, WITOLD, AND EUGENIUSZ ZARNOWSKI. Ascaris procyonis n. sp. z jelita szopa (Procyon lotor L.). Ascaris procyonis n. sp. provenant de l'intestin de Procyon lotor L. Ann. Mus. Zool. Polonici, Warsaw, vol. 14, no. 15, pp. 199–202. 1951.

STENLUND, MILTON H., MARIUS A. MORSE, DONALD W. BURCALOW, JOHN L. ZORICHAK,

AND BERNARD A. NELSON. White-tailed deer bag checks, Gegoka Management Unit, Superior National Forest. Jour. Wildlife Management, Ithaca, N. Y., vol. 16, no. 1, pp. 58–63. January, 1952.

STEYN, T. J. The breeding of lions in captivity. Fauna and Flora Transvaal, Pretoria, no. 2, pp. 37–57, illus. 1951.

STORY, H. ELIZABETH. The carotid arteries in the Procyonidae. Fieldiana, Zoology, Chicago Nat. Hist. Mus., vol. 32, no. 8, pp. 477–557, illus. 1951.

SZUNYOGHY, J. The effect of castration on the skull of the domestic cat, and the establishment of differentiating characters on the skulls of the domestic cat and the wild cat. Ann. Hist. Nat. Mus. Nat. Hungarici, Budapest, n. s., vol. 2, pp. 177–181, pls. 9–11. 1952.

TAKAI, FUYUJI. Amynodon watanabei from the latest Eocene of Japan with a brief summary of the latest Eocene mammalian faunule in eastern Asia. Rept. Geol. Survey Japan, no. 131, pp. 1–14, pl. 1. July 30, 1950.

TAKAI, FUYUJI. A summary of the mammalian faunae of eastern Asia and the interrelationships of continents since the Mesozoic. Japanese Jour. Geol. & Geogr., vol. 22, pp. 169–205. 1952.

TOERIEN, M. J. The fossil hyenas of the Makapansgit Valley. South African Jour. Sci., Cape Town, vol. 48, no. 9, pp. 293–300. April, 1952. (New: *Hyaena makapani*)

UHLER, FRANCIS M., AND LEONARD M. LLEWELLYN. Fur productivity of submarginal farmland. Jour. Wildlife Management, Ithaca, N. Y., vol. 16, no. 1, pp. 79–86. January, 1952.

URBAIN, ACH., J. NOUVEL, P. BULLIER, AND J. RINJARD. Rapport sur la mortalité et la natalité enregistrees au Parc Zoologique du Bois de Vincennes pendant l'annee 1950. Bull. Mus. Nat. Hist. Nat., Paris, ser. 2, vol. 23, no. 2, pp. 157–172. March, 1951.

VIEIRA, CARLOS O. DA C. Notas sobre os mamíferos obtenidos pela expedição do Instituto Butantã ao Rio das Mortes e Serra do Roncador. Papéis Avulsos Dept. Zool., Sec. Agric., São Paulo, vol. 10, no. 4, pp. 105–125. August 25, 1951.

VOS, ANTOON DE, AND STANLEY E. GUENTHER. Preliminary live-trapping studies of marten. Jour. Wildlife Management, Ithaca, N. Y., vol. 16, no. 2, pp. 207–214, illus. April, 1952.

WARDENBURG, FRED A. The best trophies of Africa. Animal Kingdom, New York, vol. 54, no. 4, pp. 111–114, illus. August 1, 1951.

WATSON, J. M. The wild mammals of Teso and Karamoja—VIII. Uganda Jour., Kampala, vol. 16, no. 1, pp. 89–93. March, 1952.

WATT, GRACE. An experiment in marking the grey seal *Halichoerus grypus*. Nature, London, vol. 169, p. 883. May 24, 1952.

WEBB, OLIN L., AND J. KNOX JONES, JR. An annotated checklist of Nebraskan bats. Univ. Kansas Publ., Mus. Nat. Hist., Lawrence, vol. 5, no. 21, pp. 269–279. May 31, 1952.

WHITE, JOHN A. A new chipmunk (genus Eutamias) from the Black Hills. Univ. Kansas Publ., Mus. Nat. Hist., Lawrence, vol. 5, no. 19, pp. 259–262. April 10, 1952. (New: *Eutamias minimus silvaticus*).

WILLIAMS, ERNEST E., AND KARL F. KOOPMAN. West Indian fossil monkeys. Amer. Mus. Novitates, New York, no. 1546, pp. 16, illus. March 3, 1952. (New: *Xenothrix*, *X. mcgregori*).

WINTER, KENNETH B., AND RALPH F. HONESS. Bearded grains cause death of deer. Jour. Wildlife Management, Ithaca, N. Y., vol. 16, no. 1, pp. 113–114, pl. 4. January, 1952.

YEATTER, RALPH E., AND DAVID H. THOMPSON. Tularemia, weather, and rabbit populations. Bull. Illinois Nat. Hist. Surv., Urbana, vol. 25, no. 6, pp. 347–382, illus. June, 1952.

YOUNG, HOWARD, JOHN NEESS, AND JOHN T. EMLEN, JR. Heterogeneity of trap response

in a population of house mice. Jour. Wildlife Management, Ithaca, N. Y. vol. 16, no. 2, pp. 169–180, illus. April, 1952.

ZABINSKI, JAN. Work on restitution of the European bison. Ochrona Przyrody, Krakow, vol. 19, pp. 101–115, illus. 1950.

COMMENTS AND NEWS

ANNUAL MEETING

The thirty-third annual meeting of the Society will be held at the American Museum of Natural History, New York City, June 14–18, 1953.

The Local Committee consists of G. H. H. Tate (Chairman), H. E. Anthony, T. D. Carter, G. G. Goodwin, R. H. Pough, J. Tee Van, and H. M. Van Deusen. The chairman provides the following information on accomodations:

Rate Schedule

TYPE OF ACCOMMODATION	HOTEL PARK PLAZA 50 W. 77	HOTEL EMERSON 116 W. 75	HOTEL CAMERON 41 E. 86	HOTEL ROBERT FULTON 228 W. 71	HOTEL HENRY HUDSON 353 W. 57	HOTEL NEW YORKER 34 ST AT 8 AVE
Room and Bath (1 person)	$3.00	3.00	—	—	4-6	5-8
Double-bed Room and Bath	$5.00	5.00	6.00	6.00	7-11	8-12.50
Twin-bed Room and Bath					8-12	9-13.50
Room and Bath (3 persons)	$6.75	6.75	7.50	7.50	—	12-14
Room and Bath (4 persons)	$9.00	9.00	10.00	10.00	—	$3.00 per person

Motor courts are far outside the City and cannot be vouched for. Limited parking may be had in the inner courts of the Museum.

CALL FOR PAPERS FOR ANNUAL MEETING

Make plans now for presenting a paper at the 33rd annual meeting. Members are asked to submit titles early so that an interesting program may be worked out.

In addition to the title, state time required for presentation, equipment needed, and a brief summary, if possible.

Send this information to Keith R. Kelson, Museum of Natural History, University of Kansas, Lawrence, Kansas.

NEW INDEX READY

The "Ten Year Index to the Journal of Mammalogy, 1940–1949" is ready for distribution according to the chairman of the Index Committee, Miss Viola S. Schantz. Orders should be sent to Dr. Keith R. Kelson, Secretary, Museum of Natural History, University of Kansas, Lawrence, Kansas. Remittance should accompany order. Paper bound, $3.25; cloth, $3.75. See inside of back cover for details.

BISON IN MEXICO

In a recent issue of *Journal of Mammalogy*, vol. 33, No. 3, pages 390–392, Mr. Erik K. Reed has a note on the American bison in Mexico. He says: "The bison did not, apparently, range west or south of the Rio Grande in the sixteenth century." He says that he can find "little historical basis" for the claim that within historic times the bison inhabited northern Coahuila into Chihuahua.

About 1934 Don Alberto Guajardo of Piedras Negras, Coahuila, showed me a document proving the existence of bison in Coahuila early in the last century. I have a translation of

this document from which I quote. I think the original is in the archives of the University of Texas. The document is a letter from the Alcalde or some other official at Monclova, Coahuila, dated January 24, 1806 and transmits to the proper authority at Santa Rosa an order from the governor as follows:

"Buffalo hunting expeditions in the settlements of this province are the cause of the neglect of families. The expeditions cause settlers to lose interest in stock raising. They disrupt friendship with the Indian tribes. Hereafter, settlers are not to go out in organized parties for the sole purpose of hunting buffaloes.

"You are to circulate this order among the citizens of your community."

There is a well known arroyo in northern Coahuila called Arroyo de los Cibolos, which means Buffalo Creek.—J. FRANK DOBIE, *702 Park Place, Austin, Texas.*

CHECKLIST OF PALAEARCTIC AND INDIAN MAMMALS—AMENDMENTS

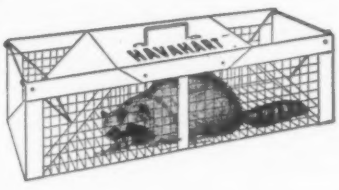
In the course of using this work, and in the light of further research, we have made various corrections, principally to dates of publication, and have discovered some omissions.

For the convenience of colleagues we propose to publish a list of these. We should appreciate it if colleagues would kindly give us a note of errors and omissions which they have themselves detected, in order that our list may be as complete as possible. It is proposed to complete this list some three months after publication of this notice.—J. R. ELLERMAN AND T. C. S. MORRISON-SCOTT, *British Museum (Natural History), London, S.W. 7.*

DATE OF ISSUE OF PREVIOUS NUMBER

Journal of Mammaology, Vol. 33, No. 4, was mailed **November 19, 1952**

HAVAHART HUMANE ANIMAL TRAPS



The *Allcock Manufacturing Company* has a large variety of humane animal traps. They have many sizes of live traps for those who are interested in catching the animals unharmed. The HAVAHART TRAPPING BOOKLET will be sent free of charge to anyone who requests it from the *Allcock Manufacturing Company, Ossining, New York.* HAVAHART traps have been used successfully by many who have been doing live-trapping experiments on small mammals. Write for the free booklet today.

SUGGESTIONS TO AUTHORS

The *Journal of Mammalogy* publishes original papers with significant new content on any phase of the science of mammalogy. While authors need not necessarily be members of the society, it is suggested that individuals publishing serious papers in this field should consider carefully the desirability of associating themselves with the American Society of Mammalogists.

Papers are generally published in order of receipt with some exceptions at the discretion of the editor. Papers over twenty printed pages in length are rarely published because of costs and limitations of space. When partly subsidized, such papers may occasionally be published at the discretion of the editorial committee.

Photographic illustrations (half-tones) and tabular matter are strictly limited because of high costs of printing. Half-tones for decorative purposes, or interest only, will not be published; they should illustrate some point or fact, best shown in this way, and essential to the exposition of the paper. Tabular matter should contain data not repeated in text.

1. All manuscripts should be typewritten on white bond paper ($8\frac{1}{2}'' \times 11''$ or $8'' \times 10\frac{1}{2}''$) with *all material, including titles, quotations, and literature cited, double spaced*. All margins should be at least one and one-half inches wide and pages should be numbered at the upper right corner. Carbon copies will not be accepted, nor will originals on onion-skin paper.

2. Titles are best if short as an aid to bibliography. Ten words should ordinarily be a maximum and less will usually serve.

3. Acknowledgments are included in the text; footnotes are avoided. Note the position for authors' names at the beginning and authors' addresses at the end of the article.

4. The bibliographic style used in recent Journal issues should be noted carefully and followed in "Literature Cited." In general, the bibliographic style will follow the suggestions made in the report of the A. I. B. S. Publications Committee, the A. I. B. S. Bul., 2 (2): 21–23. Fewer than six references should be inserted in parentheses in the text, giving author, publication, volume, paging, and year, but not title unless a book. See recent issues for style.

5. Tabular matter should be arranged as simply as possible to fit Journal page size. Note style and place for title of table in recent issues. It is not always necessary to present all data gathered. The author should exercise some judgment as to what data are essential or of general interest. Tables should be typed on separate sheets at the end of the paper and *should not be placed in the running text.*

6. Line drawings or graphs should not be made on excessively large sheets. While some reduction is desirable, an original drawing or graph twice the size of the intended cut is ample. Photographic copies of drawings or graphs may not reproduce as well as the original. The original is preferred by the editor. Large sheets are cumbersome to handle and ship, and increase postage costs. Labels must be planned to be easily legible when reduced. Lines must be solid black, not gray, to reproduce well. Graphs on cross section paper should be made on paper with pale blue lines.

7. Photographs for reproduction should be sharp, with high contrast, and printed on glossy paper. A size of $4'' \times 5''$ is ordinarily most easy to arrange. The editor prefers them unmounted. Each should be identified by a notation on the back, lightly in pencil. Legends should be typed as paragraphs, in sequence, on a separate sheet at the end of the article. It is often possible to crop photographs extensively to remove non-essential areas such as sky, foreground, background, etc.

8. A brief, concise, and informative summary is advisable at the end of the paper.

9. Proof should be read very carefully immediately upon receipt and returned promptly, with manuscript, to the editor. While errors should be corrected, the galley proof is not the place for editorial changes by the author. Necessary changes are best at the end of a paragraph, or as a new paragraph.

10. Arrangements for reprints are *made by the author with the publisher* at time of receipt of proof. A form is supplied for ordering personal or institutional supplies of reprints. Fifty reprints, without covers, are supplied, free to the author of a major article. These may be obtained only if the author orders enough to bring the total number of reprints to 100.

, *No. 1*

on any
s of the
ld con-
iety of

cretion
ause of
ally be

ecause
not be
ssential
text.
10½")
nargins
e upper
aper.
ly be a

osition
.
lly and
estions
, 2 (2):
author,
ues for

e. Note
all data
al or of
per and

e some
l cut is
riginal.
d ship,
l. Lines
ould be

ated on
rs them
egends
article.
such as

per.
mptly,
not the
a para-

receipt
eprints.
ese may
o 100.